Vol. 49 No. 1 July 1955

Quarterly

of the

National Fire Protection Association

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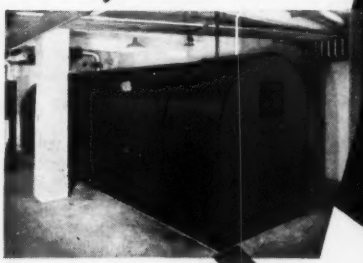

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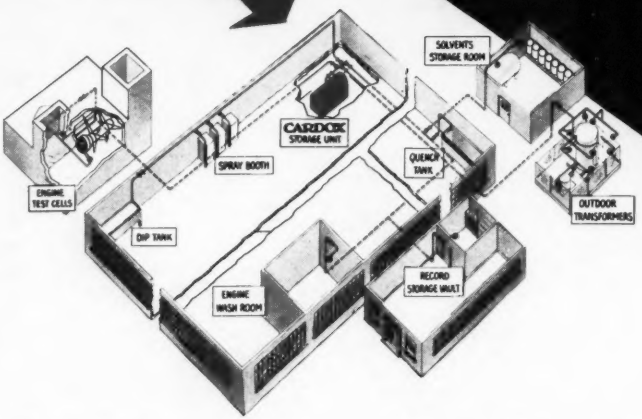

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Quarterly

The Standard Technical Journal of Fire Protection for More Than Forty Years

The NFPA is a non-profit technical and educational organization devoted to the reduction of loss of life and property by fire with a total membership of over 15,000. The *Quarterly* is one of the publications regularly provided to members. Other membership publications include *Fire News, Advance Reports* to the Annual Meeting, a *Year Book,* and many leaflets, pamphlets and posters issued throughout the year on fire prevention and control. Six volumes of the National Fire Codes are available on an annual subscription basis, one volume free and others at reduced membership rates. For full details on available material ask for the free "List of NFPA Publications."

NFPA annual dues are $12.50 for Associate Membership of which $5.00 is for subscription to this Journal. National and regional societies or associations may apply for an organization membership for which annual dues are $100; such a membership entitles four individuals to receive the periodical membership publications.

Technical committees of the Association develop means to safeguard life and property through the publication of standards covering all phases of fire prevention and protection. Your membership in the Association affords an opportunity to keep abreast of these developments and, by being a member, you help support this humanitarian activity. Popular educational literature on fire safety is constantly being produced by the NFPA for distribution through its members to the general public.

National Fire Protection Association
International

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Accounts of fires appearing in the Quarterly are based on reports forwarded to the Association except where otherwise indicated. The Association, as a body, does not assume responsibility for the accuracy of the fire reports printed herein.

This publication is indexed by Engineering Index, Inc.

Charleston Post and Courier

Charleston, S. C. pier burning on June 17, 1955. Two men killed, $2,750,000 loss. No sprinklers, high wind, no fire walls, fire department not called until after employees' failure to control fire with first aid appliances.

This pier replaced a similar pier destroyed by fire Sept. 17, 1936 due to almost identical factors. For NFPA recommendations on construction and protection of piers and wharves, see NFPA Standard No. 87.

A City Manager Looks at Fire

By Charles A. Harrell

City Manager, Cincinnati, Ohio

For years the Mill Creek Valley, one of the largest and richest complexes of industry, commerce and residence in the Greater Cincinnati area, was inundated with distressing frequency by backwater from Ohio River floods. This caused, on each occasion, property losses estimated in the millions and untold human suffering and misery.

At long last the obvious step was taken. It cost $11,000,000 of taxpayers' money to erect a barrier dam, but, on the day of its dedication, floods in this valley became a thing of the past. Today, the dam has probably more than paid for itself by *preventing* floods.

Municipal health departments now consider it their main purpose to educate the citizens and to provide the necessary measures and procedures so that ill-health becomes, in general, the exception.

In many medical laboratories and research projects the emphasis, and often the sole objective, is to find a means to wipe out entirely the incidence of a specific disease rather than to find a cure.

Any of us, given the choice, would want to be inoculated or otherwise protected *against* the occurrence of a cancer, for example, rather than to be permitted to contract it, no matter how rosy and definite the promise of a cure.

The eminent men of medicine and science who spent so much time seeking cures for typhoid fever and other waterborne diseases, such as various dysenteries and viruses, will never approach in fame those who discovered the chief origin of these diseases in drinking water and taught us to apply the treatment in advance.

Then, too, speaking of water, the municipal water departments of our cities would not get much satisfaction from a shortage of water on a hot summer day or at the outbreak of a fire, no matter how speedily they filled the need by heroic emergency action. Their glory is in providing a water distribution system in which a shortage is *impossible*.

The day is not far in the past when our police were occupied almost wholly in the pursuit and apprehension of law violators after crimes were committed. Today, there is much more emphasis on outwitting the criminal in advance of the crime, making the offense *impossible* or more difficult to commit, and in finding and removing the causes of crime.

In all of our social service work, for example, in our attack on juvenile delinquency, the thinking and action are to insulate our youth against delinquency before it enters their lives.

Our practitioners of the law will agree that the fame of the man who won legal victory in the public forum through sheer forensic ability has now been dimmed by the legal councilor who, by negotiation or compromise, keeps us, our city, or our corporation out of the courts.

The traffic problem today lies in the hands of the best engineering brains the

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Condensed from a talk presented at the 59th NFPA Annual Meeting held in Cincinnati, Ohio, May 16-20, 1955.

problem can command, not so much to get us out of traffic tangles as so to fashion our highways, our traffic laws and our traffic control equipment that traffic tangles may not happen.

Purchasing departments are not so much straining to fill a need for materials or supplies after they have run out and a shortage has become critical, as they are looking ahead, anticipating the needs, and prearranging adequate supplies.

The various building inspection services of our cities get little nourishment from the prompt application of remedial measures or the saving of lives *after* the collapse of a building. They conceive their function as assuring that no structure they permit to be erected will collapse.

Highway maintenance forces have a corps of inspectors whose objective is less the finding of visible holes to be repaired, than to discover potential weaknesses in our paved streets and apply appropriate remedies before the holes materialize.

Recently, I stood on a city sidewalk and watched a disastrous commercial fire eat up several hundred thousands of dollars of someone's assets while the fire department and its associates could only do their best to put it out, hold down the loss and prevent the fire from spreading.

It was impossible not to think, especially when the cause was later traced to carelessness of the rankest sort on the part of the owner, how much more efficient and how much more in accord with the American way of life it would have been to check that building *before* the fire.

It was not long ago that I stood on another sidewalk in another city viewing the remains of a multiple dwelling where a fire, in addition to the usual losses, had snuffed out three young lives and brought ruin to several families upon whom no greater calamity can possibly fall. I felt that whatever we may do for the victims *after* their disaster has overtaken them is not enough. I thought of the more than 5,000 lives lost last year in home fires.

I dreamed of a day when these acts of man, and not of God, would be a thing of the past. If that dream is ever to be converted into reality, it will be done by men as close to the problem as NFPA members.

The Age of Prevention

Fire fighting is very costly and the point is approaching and, in some cities may have arrived, when additional expenditures for fire extinguishing equipment will give little substantial return. However efficient we are, every bad fire is a black mark because it is prima facie evidence that the more important of our efforts has failed.

I am sure that you, and I know that most municipal officials, are what we like to call "thoroughly sold" on the need for preventive measures. So universal throughout our activities seems this principle of *prevention* rather than cure that we might call this "the age of prevention."

All of our efforts at fire extinguishment, salvage and insurance should continue, of course. What I have said is not in disparagement of them but I leave you with a Biblical injunction, which was originally spoken in an entirely different connotation, but which seems fitting here:

"These things ought ye to have done and not to leave the other undone."

(Luke 11:42)

Meeting of Board of Directors

Cincinnati, Ohio, May 16, 1955

Present

Richard E. Vernor, Chairman
T. Seddon Duke, President
John A. Neale, Vice-President
Allen L. Cobb, Past President

Warren J. Baker	Elmer F. Reske
A. L. Brown	Geo. J. Richardson
A. Leslie Ham	Roger H. Wingate
Leonard Peterson	Joe R. Yockers
J. Sharp Queener	

Percy Bugbee, General Manager; Robert S. Moulton, Technical Secretary; Beatrice L. Finley, Chief Clerk.

Business Transacted

1. The report of the Chairman of the Board was approved for presentation to the annual meeting.

Finances

2. The report of the Treasurer was approved and the Treasurer's explanatory statement also approved for presentation to the annual meeting. (The complete financial statement prepared by the NFPA auditor will be published in the 1955 Proceedings. A condensed summary was published in the May-June issue of *Fire News*.)

Technical Advisory Committee

3. The report of the Technical Advisory Committee as presented by Chairman A. L. Brown was approved including action on the following items:

(a) In consideration of an apparent conflict in jurisdiction between the National Electrical Code Committee and the Committee on Industrial Trucks, it was voted to request the Electrical Correlating Committee to comment and at the next meeting of the Board to determine whether standards for industrial trucks should be handled exclusively by the Committee on Industrial Trucks and whether the National Electrical Code Committee should be advised that industrial trucks as automotive equipment are outside of the official scope of the National Electrical Code.

(b) It was voted to authorize the creation of a new Committee on Classification of Hazardous Locations to establish classifications of hazards which can be utilized by all NFPA committees. The Technical Advisory Committee was authorized to proceed with the establishment of this new committee, including in the membership appropriate representation of the National Electrical Code Committee, the Flammable Liquids Committee, the Committee on Gases, the Committee on General Storage, and various other committees concerned.

(c) It was voted to accept the invitation of the American Welding Society to appoint a representative to their Committee on Safety in Welding which is organized as an ASA sectional committee project but with the stipulation that such representative will vote on behalf of the NFPA only to such extent as specifically authorized by official NFPA action. In further discussion of questions of policy involved in connection with the service of NFPA representatives on committees of other organizations, it was agreed to accept in principle the recommendation of the Technical Advisory Committee that NFPA representatives on committees of other organizations should not be authorized to record any official votes on behalf of the NFPA except to such extent as spe-

cifically authorized to do so by action of the annual meeting or of the Board. The Technical Advisory Committee was requested to submit a revised text of NFPA policy on this subject for action at the next meeting of the Board.

(d) It was voted to authorize the creation of a new Committee on Building Materials to include representation of the trade associations of building material producers which are members of the NFPA. The Technical Advisory Committee was requested to submit to the next meeting of the Board a draft of a scope statement to make clear the advisory character and functions of this committee.

(e) It was voted to discontinue representation of building material producer trade associations on the Committee on Safety to Life. This action was based upon the following statement by the Technical Advisory Committee:

"We feel that since the Committee on Safety to Life is developing standards on exits and not a building code the interest of building material groups does not concern itself with a sufficient part of the overall program of this committee to justify complete representation of all of the many trade associations concerned. We have felt that in justice to all our members in this field we should give all an equal opportunity which they currently do not have with only three of many building materials directly represented. We feel that with the new Committee on Building Materials all interests will have an equal opportunity in respect to the activities of the Committee on Safety to Life and the various other NFPA committees concerned with building construction matters."

(f) It was voted to confirm the appointment of Mr. C. H. Bunn, Jr. as Chairman of the Executive Committee of the Committee on Flammable Liquids and Mr. Franklin R. Fetherston as Chairman of the Executive Committee of the Committee on Gases. Mr. Ira W. Knight was appointed as a member of the Committee on Foam to serve in a personal capacity.

(g) In connection with a question of Canadian representation on an NFPA technical committee, it was voted to approve the policy proposed by the Technical Advisory Committee to the effect that the organization of each committee should be considered on its merits, that the committee should be organized in each case to provide the best qualified personnel to handle the individual subject, and that Canadian representation will be included where appropriate, but that it is not desirable to increase the size of NFPA committees unduly through duplicate Canadian and U. S. representation of groups having identical interests.

(h) Changes in the names of NFPA technical committees were made for the purpose of promoting a better understanding of their functions and to facilitate reference by putting the most important word first in the name.

Old Committee Name	*New Committee Name*
Fire and Explosion Prevention by Inerting	Inerting for Fire and Explosion Prevention
Hazardous Chemicals and Explosives	Chemicals and Explosives
Places of Outdoor Assembly	Outdoor Assembly
Protection Against Lightning	LightningProtection
Protection of Openings in Walls and Partitions	Fire Doors and Windows
Protection of Records	Record Protection
Storage of Combustible Fibres	Fibre Storage
Tanks	Water Tanks

(i) The Technical Advisory Committee reported that it had considered questions of procedure in connection with the presentation of minority reports to the 1955 annual meeting and other procedural questions and found no case of irregularity in procedure nor any occasion for Board action thereon.

(j) It was voted to confirm the decision of the Technical Advisory Committee that titanium, potassium, sodium and other combustible metals come properly

within the scope of the Committee on Combustible Metals in so far as concerns their combustible properties and uses such as for heat transfer purposes.

Industrial Committee

4. It was voted to authorize the Industrial Committee to present their report to the annual meeting, this action being necessary in view of the fact that this committee is a committee constituted to report to the Board.

"Sparky" Project

5. General Manager Bugbee reported on developments in connection with the Sparky project including the execution of a contract with Kagran Corporation to represent the NFPA in respect to licensing of Sparky products and that the previous similar contract with VIP Products Development Corp. had been canceled in accordance with the provisions in that contract. It was voted to approve this report and confirm the action on these contracts in the name of the Association.

NFPA Staff Travel

6. General Manager Bugbee reported on plans for NFPA staff travel in Europe to participate in various fire protection meetings and confer with NFPA members, such travel to be by Mr. Bugbee and Assistant Technical Secretary Tryon. These plans were approved.

Summer Meeting of the Board

7. It was voted to hold the summer meeting of the Board in Boston on Monday, July 18.

Of Concern to All Members

The following extracts from correspondence received by the NFPA staff, and news releases brought to its attention, should be of concern to all NFPA members.

First we quote from a long letter received by Mr. Bugbee, written by Mr. Vasili Sheburoff of London, Ontario:

"Dear Percy Bugbee: On October 22, 1954 I have met two of your representatives in Canada, Thomas Barr and Morris Larien. They came to London and I was stupid enough to meet and talk to them long enough until they made me sign a contract with your company. I bought off them $804.50 worth of fire retardant liquid. Since that time I have run like mad to every house in the city and have sold only one gallon for $5. There is no hopes for me to sell any more of it. Mr. Bugbee, please help me and take the supply back."

Needless to say, through the fire inspector of London, we have cleared our good name with Mr. Sheburoff but that doesn't get his money back. The fire marshal's office of Ontario is trying to catch up with the operators of this flagrant fraud.

Alarm System Racket

Here is another letter that we received only a few weeks ago from a gentleman in the Queens section of New York City. He says:

"I am writing this letter to protest about an organization trying to sell fire alarm systems under false pretenses.

These men gain access to homes by claiming that they are lecturing on fire prevention for your organization, the NFPA. They call at the house and give the housewife copies of posters on fire prevention printed by the NFPA and then make an appointment for the evening to give a lecture on fire prevention. Before I made this appointment I specifically asked them whether they had anything to sell. They said no, they were not salesmen but were lecturing for the NFPA. After coming to my home and spending nearly an hour showing my wife and myself horrible pictures of fire destruction and charred bodies, they proceeded to attempt to sell us a local fire alarm system for which they wanted $380. I am terribly provoked and annoyed at the method these people are using and since they are using your name thought you ought to know about it."

Again we have called this matter to the attention of the appropriate authorities and it is also the subject of an investigation by the National Better Business Bureau.

Ineffective Extinguishers

Less than two months ago the Chief of a volunteer fire department in a small community in Illinois wrote us about his experience. He was approached by a sales representative of a concern in Ohio selling a pint size spray type extinguisher. The proposition was that the school children in the community would sell the extinguisher to each home. The fire chief was to endorse the product and 50¢ of the sales price of $1.90 was to be turned over to the schools or the fire department for whatever use they wished to make of it. The device, of course, carried no approval label of Underwriters' Laboratories.

We have within a couple of weeks seen a newspaper report to the effect that Senator LeBlanc of Louisiana, a promoter of Hadacol, has announced his entry into the fire extinguisher field. The announcement says that the new extinguisher, known as "Quikie," is a cylindrical can similar to a large salt shaker about nine inches high and three inches in diameter containing a dry powder. The extinguisher is to sell at $5 and the report says it is "invaluable for fire protection in cars and trucks, kitchens, stores, gasoline stations, homes, offices, schools, warehouses, or any place in industry where work in progress or materials might be ruined by water or by liquid types of extinguishers."

Summary

We presume that ventures of the sort we have just described are perhaps to be expected with the rising interest of the general public in the whole broad question of fire waste control. In its eagerness to be protected against the ravages of fire, the public can be defrauded by the downright crooks and it can also be persuaded to buy ineffective fire alarm and fire extinguishing equipment by either the shady operator or the well-meaning but misguided amateur. We wish that any of our members hearing of similar cases would send us information about them, in order that the proper authorities may be contacted.

Consulting Fire Protection Engineering

By George F. Prussing, Mem. SFPE

Consulting engineers have been recognized for years as an honored group in mining and construction, in marine engineering, in chemical process design and similar fields. More recently management consultants, many of whom are engineers, have come to the front in both the administrative and technical branches of industry. Due probably more to poor salesmanship than lack of opportunity, the fire consultant has lagged far behind in recognition. Compared with these other applications of engineering science, fire protection has produced few consultants. Still the need for independent, qualified advice in our chosen field is certainly as great as in any of the other engineering specialties.

It seems to me that the market for consulting service in the fire protection field may be divided roughly into three general groups and that these each present rather separate and different problems.

Government Agencies

First, there are the Government Agencies. These range from those in the federal group, down through state, county and municipal governments and agencies to the quasi-governmental, such as the port authorities and similar corporations. State fire marshals, confronted with the need for special codes, such as those covering flammable liquids and gases, have frequently asked for professional help. Sometimes this has been furnished by industry as a matter of cooperation — and self interest — sometimes by technical organizations — but also there have been several instances where professional help has been employed at regular fees. I have personally worked on state codes for liquefied petroleum gas, port regulations for flammable liquids, fueling regulations for military aircraft and naval vessels, as well as many municipal regulations for a variety of hazardous commodities. I have also helped break such regulations when they served special interests under a specious plea of protecting public safety.

General Industry

Here is of course the most fruitful market for the fire consultant, if for no other reason than the size and variety of the field itself. At the present time this field is quite well covered by the inspectors of insurance companies and brokers. From the competitive point of view, the fact that the services of these men are not directly charged against industry creates something of a problem. It is hard to compete with Santa Claus. Occasionally, however, some executive reading the story of a tragic fire loss wakes up to the fact that insurance is not complete protection against catastrophe. In such cases men have gone over the heads of their brokers or have even gained their consent to the employment of a consultant.

This article has been condensed from an address presented before the annual meeting of the Society of Fire Protection Engineers, May 19, 1955, Cincinnati, Ohio.

Making a catastrophe survey of an industrial plant is a rather specialized job. One of the primary reasons why so frequently fire protection is weak in industrial plants is the status that has been given the local employee charged with responsibility for fire safety. There are, of course, plants in which no one is specifically charged with fire safety. But even in those plants where the need is recognized, the responsibility is placed so low in the management staff that there is little chance for an idea to percolate up to top management. Others confuse fire protection with fire control. I recently surveyed a foreign refinery where there were 350 men regularly employed in the fire brigade under competent officers, but there was no fire protection engineer in the entire management group. Other companies combine fire protection with industrial safety and place both under the personnel department. In such cases direct contact between top management and the fire service is practically precluded.

Where management has employed consulting fire service, it has found that both the service and the cost of carrying out recommended changes have been cheap in relation to the protection provided. In a certain oil producing area, it became possible to increase the output by 100 per cent. To do so, however, meant that all shipping and loading facilities would be tremendously overloaded according to original concepts of design. The question was, could this be done safely? A survey and a comparison with other similar operations elsewhere clearly indicated that the facilities could physically handle the overload. However, a fire in any one of several locations, and especially on the vast shiploading wharf could shut down production from the entire field. Added to that, the lead time on replacement of some of the items that could be ruined or damaged by fire ran about one year. While some items for replacement could be stock-piled, this in turn raised the question of the fire safety of the great warehouse areas.

The economical amount of fire protection for such an operation must necessarily be measured against the cost of shutdown in terms of profit loss. In this case a degree of fire prevention and control was recommended and installed that would be considered absurd in this country. The total cost, while high, represented only a small charge against the profits. And while these additions to fire safety were made independently and in addition to those of the insurance engineers, I doubt if there was any feeling of resentment or loss of face on the part of the companies that provided the millions of coverage on the property.

Problems of Oil Operator

Problems in other properties may be quite different. Recently a concession for the production of oil and the processing of field gas came to the end of its term in a foreign country. The American operator left and a local company formed to take over the operation on behalf of the country, assumed charge. By new technological methods of oil and gas recovery, there was a prospect of 20 to 30 more years of production. What about the plant? Could it be operated safely and for how long? Was fire protection adequate; were men sufficiently trained? What of the pressure vessels that had served for nearly thirty years? How much longer could they be safely operated? These are routine questions faced by every

oil operator as his properties and facilities age, but in this case they were all raised at once by a group that had little or no experience.

In this case, the country through one of its American trained engineers applied for help to one of our technical associations which in turn passed the inquiry over to me. After a few weeks on the job, the solution of the problem was developed with the local engineers and a program of rigid inspection and replacement of worn out equipment was instituted. Fire protection, consisting both of operating procedures and the training of men in fire control, was set up. There will be review and reassessment as time goes on. On jobs such as this, the problem confronting the consultant has two distinct parts — one, to decide what the patient needs and two, to convince him that he should take the cure. If you have gained the confidence of the management, the latter job can be done, but it is always the more difficult of the two. Sometimes it helps to unsell management on some of the gadgets which it has bought as the result of our peddlers' "pink toothbrush" type of advertising. The safety business is not without its share of buncombe. In the oil business we have not always looked with proper skepticism at what is offered us in the name of safety, but we are learning.

There is much that is new that can be passed on in the realm of technical fire protection in a specialized field such as petroleum and its allied chemicals. The work recently done by the API committee on static, lightning, and stray currents has tremendously clarified the thinking of our fire protection engineers. That study, aimed at an accurate analysis of existing problems of ignition by these so-called natural electrical sparks and arcs has gone far to debunk the hazards and to throw proper emphasis on precisely which questions must yet be solved.

Loss Litigation

A third field of activity for the fire consultant is loss litigation. While some engineers try to keep as far away from courts and lawyers as possible, it just happens that this branch of the business has interested me for years and has provided some of my most profitable employments. Perhaps it is because litigation over financial responsibility for a loss brings into such clear focus the value of accurate knowledge. And of course, since the stakes are usually high, fees are proportionately better than for routine work. I would like to add also that the fees are well earned. Anyone who has been subjected to the gruelling cross-examination which a trained court lawyer can inflict, knows that.

Court work is however only the culmination of a well prepared legal conflict. Investigation comes first and if one is very fortunate, one is called on a case in sufficient time to make a fair inquiry into the facts. Frequently, however, the case is old and the evidence on the scene has little or no value. Then one must rely on photographs, and the accumulated statements taken by investigators of varying capability. By all odds the former are the more reliable, though one could not do without the latter. Pictures have indeed actually solved some cases by their mute evidence. Others have pointed the way to new lines of investigation.

Dog-food Clue

It was a dog-food tin, lying on the floor of a cheap apartment house that had been

shattered by a gas explosion that led finally to the solution of the cause of the explosion and the defense of a lawsuit. The young man in whose apartment the explosion had obviously occurred had died. Another tenant sued the landlord for damages, alleging that lack of maintenance of the gas fixtures had allowed the gas to accumulate. It was nearly two years before that case was given to a legal firm to defend. The dog-food can, revealed in one of the excellent photographs taken by the arson squad of the local fire department, suddenly caught my eye as we studied the pictures under a powerful glass. My own dogs ate that brand and I knew the can. But nowhere in the evidence of the investigators was there mention of a dog. What had become of him? We finally found out that on the night before, the young man had given the dog away because, as he said, he was going on a long trip. There was other corroborative evidence developed as a result. The case was defended on the theory that the young man had attempted suicide — a not very effective job with natural gas, unless, as he apparently did, you tire of waiting and light a cigarette.

Photographic Evidence

The interpretation of photographs in court has won many cases. In one case it led to a settlement right in the middle of a suit. A wartime factory for extracting turpentine from pine stumps had burned. During the fire nearly all of the various digester vessels exploded and rocketed about the nearby countryside. The plant was a total loss. All the men on duty had been killed. No one could say for sure whether the fire had caused the vessels to burst or whether an exploding vessel had started the fire.

There was but one eye witness to the fire who furnished any real evidence. He was an old Negro whose shack was close to the plant. He testified that he saw blue flames running about his yard before he heard the first explosion. With that as a clew and some excellent pictures taken immediately after the fire, we got the superintendent to try to determine just which phase of the operation was going on when the fire occurred. By his knowledge of the plant and with the help of the photos, he was able to determine that a digester had been opened before it had been drained of solvent hexane and purged with steam. As a result, pine chips, dripping with hexane had gone slowly down the belt conveyor to the adjoining boiler house. The photos also showed that there had been a gas type explosion in the building before the vessels had let go. In this case, the lawyers on both sides were sufficiently convinced to permit a settlement out of court.

Immediate Investigation

The investigation of a fire or explosion immediately after its occurrence is a rare privilege for a consultant. I was called on such a case while it was still burning, after word got to the insurance carrier that there had been large loss of life. The fire department was still on the scene, searching for bodies in the ruins. Five had been recovered and there were many more victims in the hospitals. Explosion, followed by fire had wrecked a building housing a bottling works on the ground floor, with small cheap apartments on the second. News photos, which were soon on the street, showed much of the building still intact after the initial blast, before fire had completed the destruction. The pictures were taken before daylight.

I have always believed that the fire department could have come up with the true cause of that explosion, had they made a painstaking investigation. It just happened that the fire marshal was somewhat hipped on the subject of butane, and when he learned that there were two butane fuelled trucks stored in the building, he concentrated on butane as the cause. Later, when someone found the fuel inlet valve from one of the fuel tanks lying on the sidewalk in front of the building, he closed his investigation. So far as the fire marshal was concerned he had now in his hands incontrovertible proof that the truck driver, who testified at the investigation that he was trying to start his truck when the explosion blew him out of the open door of the garage, had taken the gimmick off the tank. Those of us who investigated the case for the insurance company knew that no sane and experienced driver would take the fuel valve assembly out of a butane tank. The driver had testified that he had been unable to start his truck. That checked with the evidence that the fuel tank was empty. There were two other facts which did not jibe with a butane fire or explosion. First, the driver was not burned; in fact, he wasn't even singed although he had been thrown nearly across the street and had been knocked out cold. Second, he saw and felt no flames.

Here was a case where the evidence didn't support the first hypothesis, when carefully weighed. That simply meant we had to get more and better evidence and then come up with a new hypothesis. So the remains of the building were gone over for depth of char, for flame spread and even for those heat effects that are revealed only under the glass. All pointed to a widening diffusion of a lighter than air hydrocarbon gas through the attic space above the apartments. The center was somewhere in the burned out area to one side of the garage and connected with the latter by a service stairway.

The final solution came through a review of the notes of the autopsy surgeon. He had simply testified at the inquest that the several individuals had come to their death by fire. His notes actually revealed that two persons — a man and his wife — had really died as the result of a low intensity explosion. They probably had died in bed, instantly, as the result of a gas accumulation and ignition within their apartment. Where had the gas come from? Had they lighted the gas stove in the alcove of their one room dwelling and had it gone out or been put out by the coffee boiling over? No one will ever know. But there was in every apartment cooking alcove a vent over the stove that led into the attic space. If gas *had* flowed from a gas stove, much of it would have spread over the adjoining apartments; some would have diffused into the bedroom. That was our final hypothesis; it fitted together all of the pieces of the puzzle but one — the butane tank valve. As to that, your guess is as good as mine. We learned that the garage door had stood open over a three-day holiday. Perhaps in that town there was a lad with a car, a girl, but no gas. His surprise when he unscrewed the fill valve from that butane tank must have been terrific. No wonder he didn't drop it until he got nearly to the corner.

Summary

To sum it up — in each of these several branches of fire protection, there are opportunities for the sale of exact knowledge, skill in investigation, ingenuity, and

hard work. If I had to seek work in the general industrial field, I think I would explore the market with the NFPA fire records as my Baedecker. One has but to read those records to find how great is the need for more and better fire protection advice to industry. When a firm can buy insurance for a one-story building, covering five acres without a break, and filled with five thousand tons of paper in various stages of fabrication, there is surely a market for an independent fire consulting service. And the company that took the premium and paid the loss on that firetrap would have welcomed it.

The purchase of fire protection is a problem in economics. So far as I can see it has to be sold on the basis of what it will return to the owner, not in premium savings but in ultimate protection against loss. Consulting work is rugged, and pays well, and it gets you to a lot of interesting places. I commend it to you as a man-sized substitute for the so-called security of wage slavery.

Responsibilities of Electrical Inspectors

By B. A. McDonald
President, International Association of Electrical Inspectors

We all know from NFPA records that the improper use of electricity continues to be a very significant factor in the fire losses of our Nation. In fact, the use, or rather misuse, of electricity during the year 1953 was responsible for the greatest loss of any of the known fire losses.* The record with respect to accidents and deaths is also significant. As a result, governmental agencies, insurance authorities and other interested parties have, practically from the inception of our industry, recognized this fact and either by laws, rules, regulations or codes, coupled with inspection services, have endeavored to protect the public from such hazards.

One of the greatest forces for good in this regard has been the institution and development of our National Electrical Code.† It has a background of experience over the past fifty-eight years. It is a standard of the NFPA and the National Board of Fire Underwriters. It is approved as an American Standard by the American Standards Association. Truly it is the bible of the electrical industry and there is no question as to the important role it has played in the fantastic development of the industry during the past fifty-eight years.

This is the Code of reasonably safe procedure which we charge electrical inspectors to enforce with the sole objective of protecting our property and our people from the hazards incident to the misuse of electricity. When an electrical inspec-

This article is based on a talk given by the author at the Seattle Regional Meeting of the NFPA held September 20-22, 1954.

*See also "What Causes Electrical Fires" published in the October 1954 QUARTERLY and reprinted in pamphlet form (NFPA Q 48-6), 25 cents per copy.

†Published by the NFPA, paper covered edition: $1.00; cloth bound edition: $6.00 (25 per cent reduction to NFPA members when remittance accompanies order).

tor is so charged, what are the responsibilities assumed? This question is generally answered in the Introduction to the Code where it is stated:

"THE ADMINISTRATIVE AUTHORITY SUPERVISING . . . ENFORCEMENT OF THE CODE WILL HAVE THE RESPONSIBILITY FOR MAKING INTERPRETATIONS OF THE RULES, FOR DECIDING UPON THE APPROVAL OF EQUIPMENT AND MATERIALS, AND FOR GRANTING THE SPECIAL PERMISSION CONTEMPLATED IN A NUMBER OF THE RULES."

It is difficult, without a few years of experience, to evaluate the significance of the responsibilities which these few words, in one sentence, place on an inspector. They are very serious in nature and involve many considerations. They are serious because they treat with hazards which may result in serious fires, personal injuries and loss of life when not properly safeguarded. Let's examine each one of the charges placed on the inspector as it appears in the introduction to the Code.

Interpreting the Rules

The first responsibility concerns the interpretation of the rules. Since the Code cannot anticipate the variables usually involved with field installations, it follows that many of the rules are not tailor-made to fit all conditions which may be encountered in the field. They are not like a rubber suit which may be expanded, contracted or distorted to fit any occasion. As a result, many times they are general in nature and it is the responsibility of the inspector, in line with the particular conditions involved, to decide the proper application of such fundamental rules. Such decisions should be based on a clear understanding of the hazards, a technical understanding of the factors involved, and a background of experience, the great teacher, which all of us cherish when important decisions must be made.

To help the inspector in some cases, a procedure is recognized by the Code whereby Official Interpretations may be obtained direct from a standing committee of the National Electrical Code Committee.* When such interpretations are given they are published by the NFPA in FIRE NEWS, by the IAEI in their NEWS BULLETIN and by various trade papers. Since such decisions usually concern controversial subjects, only infrequently does the average inspector need to call for such official interpretations. There are many more occasions when the inspector must decide, in line with existing conditions, just what must be done. He must answer questions concerning mechanical injury to conductors and equipment, the extent it is necessary to protect an ungrounded cable, how many clamps are needed on a conduit run to support it adequately. These and similar questions continually arise. It would be entirely impracticable for the Code to visualize and make specific rules to cover every possibility which a field application presents. It therefore becomes the responsibility of the inspector to decide such issues on the basis of sound engineering and good common sense coupled with experience.

In the case of hazardous locations (as defined in the National Electrical Code, Article 500), the inspector must assume a very serious responsibility since it is his job to determine the extent of the hazardous area, the nature of the hazardous gases, vapors or dust, proper ventilation, and many other factors which must be

*See page 447 of the current NFPA printing of the Code.

considered in applying the rules for such locations. The National Electrical Code assists to a considerable degree in arriving at the right conclusion but it cannot cover all of the variables which may be encountered. In many cases the standards of the NFPA may be consulted for assistance. These standards go into more detail with respect to the hazards involved with occupancies such as dry cleaning (NFPA No. 32), spray finishing (NFPA No. 33), pyroxylin plastics (NFPA No. 42), flour and feed mills (NFPA No. 61C), pulverized coal (NFPA No. 60A), and a host of other hazardous operations. These standards of the NFPA provide a source of reliable information, allowing the inspector to place responsibility on an authority well recognized nationally.

The Underwriters' Laboratories also offers the inspector considerable assistance in its Gas and Oil Equipment List.* Here, in the list of "Products Classified as to Fire Hazards Only," he may obtain information concerning the degree of hazard involved with such liquids as ether, gasoline, alcohol, kerosene and paraffin oil. The NFPA publishes a Flammable Liquid Trade Name Index (No. 325A),† which is also a helpful guide. Here he may gather reliable information concerning cleaning liquids, protective coatings, fumigants, insecticides, plasticizers, solvents, refrigerants and many other liquids which are in common use today and are hazardous to varying degrees.

Approval of Equipment and Materials

The next important responsibility of the inspector concerns his approval of electrical equipment and material. This is a direct charge given by the Code, which likewise infers that the facilities and reports of adequate testing laboratories should be used in determining this very important consideration.

In the early days of our electrical industry, it was apparent that the scope of an inspector's activities could not and should not embrace the field of laboratory investigation of materials and equipment. This is a specialized field requiring personnel trained for the job. It involves the promulgation of standards, fact-finding reports, factory and field inspections and many other factors, all of which must be considered in arriving at the correct answer to the word "approved" as used in the Code. As a result, it was found to be expedient that such a service should be rendered by laboratories and sixty years ago the Underwriters' Laboratories was founded for this purpose. I believe we all know the important role the U. L. has played in the development of our industry. It has eliminated the necessity for repetition of examinations by different examiners, frequently with inadequate facilities for such work. It has stabilized our industry by eliminating the confusion which would result if each and every Inspection Bureau had to conduct its own tests. In the interests of economy, practicability and uniformity it has been a boon to all of us concerned with the electrical industry and I believe the electrical inspector who has the responsibility for determining the fitness of materials and devices for use under the rules of the National Electrical Code would be lost without the assistance which is available through this organization.

While the scope of the Underwriters' Laboratories is very large and covers a

*Available from the Laboratories, 207 E. Ohio Street, Chicago 11, Ill. (no charge for single copies).

†Available from the NFPA, $1.25 per copy.

high percentage of the materials an inspector must judge, the fact remains that there are some materials which are beyond the practical range of the laboratories. Equipments involving high voltages, amperages and horsepower come under this heading. In such cases the inspector who has the responsibility for the approval of such materials finds himself quite lonely; only then does he fully realize the important role played by the U. L. when in a position to help. As a result he usually consults with the utilities, manufacturers and other sources of reliable information to justify his decision.

Occasionally he has the full responsibility for the use of materials of special design which are tailor-made to fit some peculiar situation. With little assistance from the Code and the U. L., he must apply the fundamental rules of the Code to the best of his ability and in line with his experience determine the suitability for use of such materials and installations. It also follows, with a rapidly expanding industry, that new methods are developed before any standard or Code rule has been established. In such cases an inspector has the authority, as delegated by the Code, to decide if the method should or should not be used.

I recall several years ago a case where materials for radiant heating came to the attention of a doctor in the western part of New York State. The materials were made in Seattle by the Roberson Company. The doctor, through his architect, requested approval of this material for the purpose of heating two homes he was building. At the time I knew very little concerning radiant heating involving the installation of wires buried in the plaster of walls and ceilings. We had only some experience with house heating involving the circulation of hot air under floors of fire-resistive buildings. Our first reaction was unfavorable. In view of the definite request, however, we felt that we, as the authority enforcing the Code, had a responsibility to face. It was up to us to investigate the entire matter before a decision was made. We obtained all of the information possible from the manufacturer. We found that the State of Washington had already recognized this method of heating and had set up rules governing such installations. We obtained a copy of these rules. We had samples of the material to be embedded and we had the record of experience over a few years to guide us. As a result, we agreed to accept this material on a trial basis when installed in accord with the provisions of the State of Washington. At the present time the U. L. lists eight different manufacturers of such cable units and the N. E. Code has provided rules for their proper installation. I cite this as an example of a situation which occasionally arises where the inspector, with very little assistance from the Laboratories and with resort only to the general rules of the Code, must made decisions in line with the responsibility he has assumed. These are special cases which in no way are intended to indicate that such procedure should be followed when approved materials and devices are available.

"Special Permission"

The third responsibility delegated to the inspector by the Code concerns provisions which are only recognized by "special permission" of the inspector or the authority enforcing the Code. When such a provision appears in the Code, it is an indication that the inspector must pay

particular attention to the material involved, the wiring design, the installation, and any unusual conditions which may be present. As an example, bare-conductor feeders are recognized for use by special permission. Such an installation usually involves the installation of bare conductors fabricated on the job. Questions concerning insulation, supports, fire cutoffs when floors are pierced, and other problems when bare conductors of large current carrying capacity are used, must be answered by the inspector. Under grounding, specific rules are provided for fixed equipment but there also is a provision which allows the inspector to approve other means of grounding by special permission. Several rules provide that some equipment shall be accessible only to qualified persons. Who is qualified? What standards are involved? The inspector must answer such questions. The question of interconnecting a lightning arrester with the secondary neutral, in a manner other than specified, may be permitted by special permission. These and many other applications which involve special consideration come within the scope of the inspector's responsibilities.

In addition to the foregoing some rules involve the use of general terms such as "if practicable," "neat and workmanlike," and "firmly secured to the surface." What is practicable? If you asked a dozen inspectors to rule on an installation which involved the use of this term, you might get various answers and all could be correct in line with the field conditions each inspector has in mind. The same applies to "neat and workmanlike" and "firmly secured." Many such questions may only be answered in line with the field conditions involved. One of the principal objectives of the Association I represent, The International Association of Electrical Inspectors, is to promote a uniform understanding and application of the rules of the National Electrical Code. I believe that any inspector, contractor or engineer who, through his membership in our organization, has fully availed himself of the information available through our publication the NEWS BULLETIN, our Chapter and Section meetings, will agree that we have contributed greatly towards a uniform understanding of such terms and I am sure that we have greatly assisted the inspector in fulfilling his responsibilities.

Many of the basic provisions of the Code have exceptions, many rules are made mandatory by the use of the word "shall," and some are made advisory by the use of the word "should." Naturally, it may be more difficult to comply with "should" rules than it would be to satisfy the "shall" rules. Some folks in our industry only know the "shall" rules and are not interested in the recommendations for improvement indicated by the "should" rules. I believe any electrical inspector has a responsibility to see that the distinction between these terms is clearly understood by all parties concerned. It has been my experience that an inspector may help to raise the standards of wiring in his community by publicizing the recommendations of the Code and not stressing the minimum provisions. There are too many who honestly believe that full compliance with the Code will result in a "gilt-edge" job. This is not true and the Code under its introduction so advises. Again, I repeat it is a responsibility of the inspector to make this fact known to all and to promote wiring which not only considers basic minimum provisions necessary for safety but provisions which also

consider adequacy and convenience. It has been proven, time and time again that mere compliance with a minimum standard, in a rapidly expanding industry such as ours, may act as a boomerang within a few years, in the form of a dissatisfied public which finds that it cannot purchase and install some of the new electrical innovations which continue to appear without expanding electrical facilities at considerable expense.

Summary

These cover the important responsibilities of an electrical inspector delegated to enforce the rules of the National Electrical Code. When you consider the nature of the hazards to be safeguarded, the fire and personal injury hazards, it is quite evident that the electrical inspector shoulders a heavy responsibility. There is no definite yardstick by which his work may be evaluated. It cannot be measured in dollars and cents. It may be reflected to some degree in the records of fires and personal injuries but this could be a very unfair method of appraisal, especially where the volume of work far exceeds the physical ability of a rugged individual to fully satisfy his responsibilities. With a rapidly expanding industry, with plans for doubling the generation of electrical energy within a few years, we cannot expect existing inspection facilities to fulfill their responsibilities unless their facilities are likewise increased. Codes, laws and regulations are important factors in keeping electrical fire losses at a reasonable minimum only if they are rigidly enforced.

If the inspector in your locality appears to be tough and rugged, unyielding and loath to compromise, do not be too hasty with your adverse judgment. He knows that he cannot compromise with fire and personal injury hazards. He knows from experience that the destructive force which is inherent in the servant electricity may be held in rein only if rules are enforced and not discounted. He has seen the results of electrical failures and realizes the serious nature of the consequences. He realizes, when things go wrong that he, the inspector having jurisdiction, must render an account of his stewardship and he does not wish to be found wanting. If he can face the judge and the jury with a clear conscience and be able to show that he has discharged his responsibilities for enforcing the Code in an impartial manner with strict adherence to its provisions; that he has availed himself of the services, whenever possible, of the Underwriters' Laboratories and the National Fire Protection Association, I believe he will find himself in a position with little to fear from anyone.

Resonant Heating — A Cause of Explosions

By Henry Morton, Commander
Department of the Navy, Bureau of Ships

In an address presented at the 59th Annual Meeting of the NFPA, May 16-20, 1955 Commander Morton presented a detailed account of current research projects of the Bureau of Ships which have been undertaken as a result of recent disastrous shipboard explosions involving hydraulic machinery. That portion of Commander Morton's address dealing with the theory of resonant heating is presented here.—Ed.

Explosion hazards afloat have always been of prime interest to the Navy. At sea, even a relatively minor explosion may cause you to fail in your mission, while a serious one, even though no one may be killed by the explosion itself, can result in the loss of your ship. This means that "all hands" have lost their home as well as their place of work. Unless assistance is quickly available from nearby ships, it may result in heavy loss of life from drowning or from exposure.

Current Research Projects

In view of apparent existing hazards and recent experiences in machinery casualties, the Bureau of Ships has established an extensive research program to obtain ignition-combustion data. Some of the most interesting projects are:

a. Study of spray flammability characteristics of fluids.

b. Evaluation of fire resistant qualities of hydraulic fluids.

c. Investigation of flame propagation in high pressure gas systems.

d. Investigation of flame coolers.

e. Investigation of hydraulic shock absorbers.

f. Compression-ignition tests of hydraulic fluids.

g. Ignition delay tests of fluids.

The Resonant Heating Theory

From the investigation of compression-ignition tests of hydraulic fluids a unique process of combustion has been discovered. The temporary terminology assigned this phenomenon is "resonant heating." It is accomplished by directing a low pressure compressed air jet into a restricted cavity which apparently causes compression wave surges similar to a water hammer. These compression waves are converted to heat, and the accompanying temperature rise is sufficient to cause ignition. A block of wood can be readily ignited by using low pressure compressed air (15 psi gage). The experiment can be accomplished very simply as follows:

a. Saw 8 inches from a broom handle.

b. Drill a 3/16-inch diameter hole in the center of the circular cross section longitudinal with the grain to the depth of approximately the length of the drill.

c. Apply a continuous jet of air into the hole. When the proper resonance is obtained, the wood will burn.* Adding dust to the hole appears to double the rate of temperature rise and thereby accelerate ignition. Substituting pipe fittings for the wood block and applying the same basic principle, the temperature rise is sufficient to cause ignition of fuel films in the piping system. In fact, numerous heretofore unexplained explosions in air, oxygen, and other hazardous gas systems can be attributed to this basic concept.

*Ignition of a wood block by compressed air was demonstrated by Commander Morton at the conclusion of his address.

The Lumber Yard and the Community

William G. Schultz, Chief Engineer
Lumbermen's Mutual Insurance Co., Mansfield, Ohio

January 17, 1950, Fort William, Ont. Driven by a 30 mph wind, fire originating in the lumber yard spread to eight dwellings and five apartments (one in foreground of photo). The fire was coming through the roof of an unsprinklered lumber warehouse when first noticed at 3:45 A.M. Fire officials believe the fire would have spread much farther had it not been for excellent public water supplies.

The record is spotted with numerous fires originating in lumber yards which spread to adjacent property. Homes, business places, even hospitals, schools and court houses, vital to the community welfare, have been destroyed by these spreading fires. There is no doubt that the lumber dealer has a responsibility toward his community in the matter of safeguarding his property, as well as the entire community, from a conflagration starting on his premises.

This article was adapted from an address presented by Mr. Schultz at the 59th Annual Meeting of the NFPA, May 16-20, 1955. Mr. Schultz showed pictures of several lumber yard fires, some of which accompany this article.—Ed.

Inherent Hazards of Lumber Yards

What makes the lumber yard such a prominent conflagration breeder? First, the buildings are principally of wooden construction, usually large, undivided areas and with heavy concentrations of fast burning material. This type of construction and occupancy make an attractive target for arsonists and incendiarists, and the records show that they are frequently the choice of these perverts. Lumber yards are also an irresistible attraction to children, as we all know from our own childhood. The piles of lumber to climb over, the hiding places for games, and the generally easy accessibility make them a haven for children and the record bears

out this contention. Children and pyromaniacs are not the only ones attracted to lumber yards. Since yards are usually located near railroads, tramps and hobos plying the rails often seek shelter in the open sheds or between piles, and with plenty of fuel available at arm's reach, they can readily cook their mulligan stew, even on wood floors of lumber sheds. Trespassers using lumber yards for short cuts to and from work, thieves taking lumber from the yard, and many other trespassers make the lumber yard vulnerable to fire.

Table 1. Causes of Lumber Yard Fires

Cause	Per Cent
Electrical	18.4
Sparks	15.9
Lightning	10.8
Heating equipment	6.9
Smoking	6.0
Exposure	5.6
Trespassers, ignition by	5.3
Spontaneous ignition	4.2
Grass fires, ignition by	1.8
Other known causes	3.2
Unknown	21.9

Table 1 shows the causes of 2,941 lumber yard fires. Table 2 shows where these fires started. From these tables it can be readily determined that 91 per cent of lumber yard fires start in buildings, not in the yard areas, and for the most part originate in the manufacturing units where electrical equipment, sparks, lightning, heating equipment, and smoking are the major sources of fire.

Table 2. Places of Origin of Lumber Yard Fires

Place	Per Cent
Manufacturing buildings	47.1
Offices, warehouses or non-manufacturing buildings	34.8
Boiler houses	4.5
Shavings vaults	4.6
Open yard areas	9.0

Delayed detection is very frequently a contributing factor in large-area lumber yard fires. Records of the Lumbermen's Mutual Insurance Company show that 54 per cent of the lumber yard fires over a seven-year period started after closing hours or during shut-down periods. With no watchman service or automatic detection equipment provided, these rapid spreading fires were out of control of ordinary fire fighting facilities before they were detected.

How Some Lumber Dealers Have Protected Their Neighbors

You each probably know of an old yard where buildings were built adjacent to the yard years after the yard had been established. Lumber dealers are mighty fine people. A large majority are fire conscious and willing to go far beyond the legal requirements to safeguard nearby property.

In Sault Ste. Marie, Michigan a lumber yard of primarily wooden construction was

April 25, 1953, Sault Ste. Marie, Mich. Fire set by boys playing with matches destroyed a lumber shed, yard-stored lumber and a 2-story mill. Several dwellings at one end of the lumber yard undoubtedly would have been destroyed but for a high concrete wall erected several years ago by the lumber yard owners.

burned to the ground, yet a wooden dwelling less than 10 feet from the main lumber shed was undamaged. Why? because the lumber dealer had built a 12-inch reinforced concrete wall to the height of the eaves of his shed, which entirely protected the dwelling.

A disastrous lumber yard fire occurred in Cleveland, Ohio, August 16, 1953. This yard, although large, was very congested and consisted principally of wooden structures, with the exception of the fire-resistive warehouse. However, the dwellings surrounding the yard received only minor damage because the lumber dealer had erected an 18-ft.-high masonry wall between the yard and the dwellings.

In the offices of all companies insuring retail lumber yards, records reveal examples of lumber dealers accepting their responsibilities to their community by purchasing all surrounding land to prevent others from building nearby. There are also many examples of yards protected by sprinkler systems, some with supervisory alarm service, yards with automatic fire detection and alarm signal systems, yards with standard watchman service, yards with hydrants and hoses, standpipe systems, extinguishers, and lightning rod systems, yards with excellent control of heating, wiring and smoking hazards, yards with good refuse disposal systems, and in fact, yards that in every way are demonstrating their willingness to do all possible to prevent a disastrous fire.

Municipal Regulations

There is no uniformity of regulations on lumber yards throughout the country. The NFPA has developed recommended standards for the storage and handling of

Associated Press

August 16, 1953, Cleveland, Ohio. Residents of 100 dwellings were evacuated when fire swept through the lumber yard. That none of the dwellings was burned was due in part to a masonry wall erected along one side of the yard. The wall had been built following a previous fire that had spread through several exposed dwellings.

May 6, 1950, Rimouski, Que. Fire originating in a lumber yard jumped a 200-foot-wide river and destroyed 319 homes, 20 stores, a movie theater, hotel, court house and jail, a hospital, convent and school. High winds, dry weather, and inadequate fire fighting equipment were factors influencing fire spread.

lumber so that the fire hazard and danger to life and property may be minimized, but in relatively few instances have sincere efforts been made to comply with these standards.*

In some communities, the city fathers have attempted to solve the problem by imposing drastic restrictions on the lumber yards, but some of these restrictions, when imposed on yards already established for many years, have put the yards out of business or moved them out of the city with the same end result. Unfortunately, many of these regulations are imposed immediately following a conflagration when tempers are high, emotions abnormal, and animosity toward all lumber yards is unbridled. At such a time, regulations can be made too severe to be practical.

In Philadelphia, the Board of Safety and Fire Prevention enacted regulations for lumber yards following several fires that spread to or threatened dwellings. One proposed regulation would have required that fire walls be built to the height of the exposed buildings. Lumber dealers working with the Board of Safety and Fire Prevention were able to modify this proposal to permit the City Fire Marshal to determine the height of the wall. The Board also ruled that any wood-framed building housing lumber or millwork, and exceeding 5,000 square feet in area, must be equipped with an automatic fire detection system. But, they permit the burning of rubbish, trash, and wood refuse in an open burner 50 feet from buildings, provided a metal shield 6 feet high is erected between the burner and buildings.

In Cincinnati, in the absence of local regulations, the fire department enforces

*NFPA No. 47, Standards for Retail Lumber Yards and Lumber Storage Yards; available from the National Fire Protection Association. Price 15 cents.

the NFPA Standards for Retail Lumber Yards and Lumber Storage Yards.

The imposition of laws and regulations by the large majority of aroused citizens, after a conflagration, against a very small minority is the easy way out. The realistic approach is for the entire community to recognize the rights of the minority and by conference and cooperation, solve the problem to the best interests of all concerned. We must recognize that old established yards cannot pull out their roots and relocate without crippling loss.

The Lumber Dealer's Responsibility

The lumber dealer has very definite responsibilities. These responsibilities are imposed by law, by insurance interests, and by moral obligation or conscience. From the legal aspect, the lumber dealer is expected to be a prudent man operating a business known to be a conflagration breeder. In spite of the fact that he may be prudent, if he violates any law imposed on him for the safety of the community, he is by that fact criminally negligent and has committed a tort to society and can be held legally liable.

City, state, and county officials, acting under powers delegated to them by the State, may enact laws creating fire regulations for the protection of persons and property. The violation of such a legislative enactment may be negligence in itself if the person harmed is one of the persons whom the regulation is intended to protect, and if the harm which has occurred is of the type which the regulation was intended to prevent. Violations of such regulations are misdemeanors in the eyes of the law and are generally punishable by a fine of not exceeding $500 or by a sentence of six months in jail. In actual practice, however, the courts are lenient and levy nominal fines for infractions,

Arthur N. Hough

September 3, 1953, Newell, Iowa. Boys playing with matches and gasoline set this lumber yard fire while the yard was not operating and was without the protection of a watchman. Flames were beyond control in the yard when the fire was discovered at 5:00 P.M. by a neighbor and later spread to the seriously exposed grain elevator which can be seen in the background.

Dawson County Herald

August 20, 1947, Lexington, Neb. Fire that was set in this lumber yard in the center of the city spread to and destroyed an adjacent furniture store and four other stores. No watchman or automatic protection was provided for the lumber yard.

thus falsely educating the public that it is cheaper to pay the fine than to comply with the regulation. What is not generally understood is that the payment of a fine does not absolve the violater from his legal liability. In fact, a violation existing in a property and passed unnoticed by fire inspectors does not void the operation of the law, nor is the owner of the building absolved from civil liability through terms of the lease. Numerous courts have held that where injuries or death from fire were due to failure of the owner to comply with fire regulations, the owner is liable. There is a civil liability if such violation is the proximate cause of any injury or loss sustained by any person who is not himself guilty of contributory negligence.

These are excellent arguments for full cooperation with a fire inspector, even to the extent of calling conditions to his attention, should they be overlooked.

In most cases where the city codes are enforced practically every yard in the city is required to build fire walls, to subdivide the sheds into 5,000 square foot units, or install sprinkler systems. Practically all yards are required to provide yard hydrants fed by a 75,000 gallon gravity tank in the city of Cleveland because the city water pressure is inadequate in most of the city. When the city water supply is known to be limited, can we justly impose requirements for yard hydrants fed by costly gravity tanks, or is it the responsibility of the community to strengthen its supply so that it can properly protect its industry?

The Community's Responsibilities

The responsibility for the bad lumber yard fire experience does not lie entirely with the lumber dealers. The community itself is often responsible. Many lumber yards were erected in the outskirts of towns away from other property, many years ago, but as towns expanded, buildings were built adjacent to these yards and today many of the yards that were once

sensibly located are entirely hemmed in by dwellings and other buildings. For example, in Cleveland a very large yard, once well separated from other property, is now directly exposing a large trailer court with trailers against the fence, and in an area not zoned for residential purposes. The lumber dealer is complying with the local restrictions and provides proper distance from lumber to his lot line, but what protection is 15 feet when a large yard is ablaze? Such use of adjacent property should not have been permitted, especially since many of the trailers house children, and a playground is provided adjacent to the yard. Even standard fences can't stop the more venturesome boys from playing in a lumber yard.

The fire storm characteristics of a lumber yard fire, the widespread areas, the difficulty of access to fire apparatus, the large area of buildings, the light construction, the substandard piling of lumber, and fire fighting facilities often far below the requirements for handling fires of these magnitudes, make the lumber yard a potential conflagration breeder. After a conflagration in a community, all lumber dealers are faced with an antagonized public ready to impose drastic measures that may be completely unreasonable, but because of the stress of circumstances seem necessary for public protection. The dealer is faced with strict enforcement of laws, both good and bad. If he survives the fire financially, he is at least badly crippled and unable to comply economically with regulations, and is often forced out of business leaving many of his fellow citizens without jobs. He may be required to move his operation beyond the city limits to a less desirable business location, which some day may again be built up if the community does not recognize the value of sound zoning laws to prevent

May 9, 1950, Cabano, Que. This fire started when sparks from a refuse burner ignited a pile of dry maple in the lumber yard. High winds spread flames to a garage, through hotels, 118 homes, 33 stores, another lumber yard and lumber mill, a bank and miscellaneous stores and offices. Inadequate fire fighting facilities contributed to the size of the fire.

closely built property. He may be involved in costly law suits which may bankrupt him. The outlook after a conflagration is black, and therefore the only salvation is to attack the problem as a real and present problem of great importance, before a conflagration occurs.

The lumber dealer must now accept his individual responsibility to his community by acting more sensibly than an ordinary prudent man under the same circumstances. He must provide fire walls to protect neighboring property, subdivide large-area buildings into smaller fire divisions by fire walls, equip at least the major buildings with sprinkler systems or alarm signal systems and provide sensible distances between other buildings and yard areas. He must comply strictly with fire regulations and cooperate with inspectors. In addition to maintaining a profound fire consciousness, the lumber dealer should also provide good fence protection and a standard lightning rod system.

These are all drastic measures, but lumber yard fires are serious threats to every community and the lumber dealers and the city fathers should get their heads together before it is too late. Uniform state regulations will prevent discriminatory city regulations which throw unequal expense factors on competing lumber yards and produce unfair competition. The enactment of just and reasonable laws, proper enforcement of those laws, and judicious judgments by the courts, followed by sensible punishment of violators, will go a long way toward helping the lumber dealer and the community solve this serious conflagration problem.

Cicero Fire Department

April 25, 1953, Cicero, Ill. Fire believed caused by a carelessly discarded cigarette had completely involved an unsprinklered 2-story lumber storage shed in a remote corner of the lumber yard before discovery. The photo shows two buildings on the perimeter of the yard ignited by wind-driven flames. The combined efforts of three fire departments saved half the yard and several other buildings in the path of the fire.

Safer Stowage of Hazardous Cargoes on Ships

By Carl E. McDowell

Executive Vice-President, National Cargo Bureau, Inc.

On November 2nd, 1953, at Boston, a ship was discharging 140 drums of sodium peroxide. Each drum weighed 433 pounds. Sodium peroxide is a white or yellowish powder obtained by passing heated air over metallic sodium. A small quantity of water combined with sodium peroxide and organic material will produce fire and sustain continued reaction.

The sodium peroxide had originally been stowed at Hamburg, Germany, in the 'tween decks of the ship. At Antwerp, Belgium the drums were moved to the lower hold. They were stowed with bales of rubber waste, cases of glassware, bales of wool, and a large quantity of a bauxite ore residue known as bog ore. The bog ore (which is a stable, reddish brown earthy material containing about 45 per cent moisture by weight) was separated in the hold by a canvas and dunnage screen. The only means of access to this lower hold was through the hatch square.

Sodium peroxide is hazardous cargo. Its stowage, packaging and labeling is subject to Coast Guard regulations when being stowed aboard ships in United States ports. The re-stowage of the drums to the lower hold on this ship was contrary to our U. S. regulations and would not have been permitted if the ship had been loading in a U. S. port. Furthermore, the commodity had not been properly described on any dangerous cargo list, manifest or other ship's document, contrary to the requirements of the International Convention for Safety of Life at Sea, 1948.

It has been indicated that this oversight resulted in a failure to advise the longshoremen at Boston of the nature of the commodity that they were handling, and because of this failure, that inadequate care was being used in the handling of the chemical. At the time the ship was discharging the drums, approximately 22 longshoremen were in the hold. At approximately 2:30 P.M. the covering lid of one of the drums came off in handling and about 20 pounds of sodium peroxide spilled to the floor of the hold where it came into contact with some water from an unknown source. The material almost immediately began to burn and the fire spread rapidly to organic material in the hold. Efforts to stamp out the flames merely spread the fire.

As a result of this situation, 8 persons in the hold of the ship lost their lives. Seven persons were hospitalized because of burns and respiratory injuries. Damage to cargo and ship was limited.

The ship, in this instance, was alongside a pier and the cargo hold was open and being worked. The Boston Fire Department was available and extinguished the fire. Coast Guard and Naval small craft stood by. Army and Navy medical officers were available.

This article is based on an address presented at the 59th Annual Meeting, NFPA, Cincinnati, Ohio, May 16-20, 1955.—Ed.

Boston fire fighters struggle to control flames which took seven lives when a dangerous chemical stowed with general cargo became ignited while being discharged from a foreign ship. Proper stowage of cargo would have averted this tragedy.

Think of the awful possibilities if a lid on one of the drums had worked loose at sea! A fire aboard ship at sea is a dreaded casualty. No other experience dramatizes more tragically the isolation, the naked self-sufficiency of the shipping venture. The first indication of a fire at sea galvanizes the crew into instant action, for men of the sea are very fire conscious. The entire ship, all of the cargo and all life depends on the speed and effectiveness of their fire-control efforts. Help may be a long time in coming.

Control of Fire at Sea

However, conditions at sea for controlling fire are adverse. The crew member is primarily a seaman and secondarily a fire fighter. The source of the fire may be deep in the stowage, hence inaccessible, in a cargo compartment containing maybe a thousand tons of solidly packed goods. And the types and mixture of cargo may seriously complicate a fire and its control.

Over the years, new and better methods of building ships have been drawn up by naval architects and others. More fire-resistant materials are being used in accommodations. Fire extinguishing systems have been installed, such as sprinkler systems in passenger and public rooms, and systems for use of steam-smothering and CO_2 in cargo spaces and store rooms. CO_2 has also proven itself in machinery spaces. Smoke detectors and fire alarm signals are on many ship navigation bridges.

Dangerous cargoes—that is to say, commodities that are inherently hazardous—are a leading factor in fires aboard ship. To mention a few commodities among the many with which you are familiar, flammable solids such as metallic sodium must be packed in airtight containers because this commodity will burn if air is introduced; therefore, it is necessary to make certain there are no leaky containers that would permit air to come in contact with the material. There is sufficient moisture in the air to activate this chemical.

Corrosive substances must be kept separate from flammable materials, because leakage of contents coming in contact with them will cause damage and possibly fire. Each commodity must be stowed in the vessel to avoid possible contact and must also be secured so that it cannot get adrift and be damaged because of the rolling of the ship.

Ventilators leading to compartments in which flammables are stowed must be fitted with flame screens and the commodities according to their particular degree of hazard must be so stowed as to be accessible in case of fire.

Sulphur readily takes fire from friction as well as from the introduction of other chemicals. The fine sulphur dust which accumulates during loading must be carefully swept down after loading.

Cotton, a commodity with a bad fire record, must be carefully observed while being loaded and stowed aboard a vessel. Friction of the metal bands against concrete or steel will cause sparks which will readily ignite the loose fibre and burlap covering.

There is always danger of explosion and fire from leaking containers of liquefied petroleum gases such as propane or butane. For this reason, these commodities are allowed to be stowed only on the open deck.

In brief then, many commodities which may be relatively inert or safe when stowed aboard ship can become violently active and cause fire or explosion if allowed to come in contact with other substances.

Knowledge of the characteristics of commodities offered for shipment aboard ships has become a specialized requirement of ship operators and surveyors. The expansion in volume and frequency of shipment of hazardous cargoes has contributed to this requirement. The fast changing world of chemistry and science necessitates continuous alertness in order to prevent fires.

Prevention of Fire at Sea

In connection with fire prevention at sea, ocean marine insurance underwriters have for generations been fire conscious. They are as concerned with fire prevention as are the fire underwriters.

Marine underwriters, the shipping and shipbuilding industries, and the Coast Guard have steadily improved the means of controlling and reducing the danger of fires in cargo. This is being accomplished by continuous individual study and group action in this country and at the international level.

The means of control other than construction of the ship and the fire fighting equipment include: the location of stowage of cargo aboard ship; the stowage of one hazardous commodity in relation to other commodities; the type and size of container; and above all the careful in-

spection by trained surveyors of the stowage of cargoes aboard ships.

While ocean marine underwriters began over a hundred years ago to take an interest in safe stowage of cargoes aboard ships, the matter of the public interest in safe stowage has only recently been demonstrated in the form of regulations. Over a period of years the Government absorbed as regulation the practices for stowage recommended by underwriters. These are now known as Coast Guard regulations for stowage of hazardous goods and of grain and other bulk cargoes that are subject to shifting.

Even more recent than our own government's regulations is the trend toward international agreement to regulate stowage and labeling of dangerous goods. Safety-at-sea regarding construction of ships, life-saving equipment, communications systems and other matters has been a subject of international agreement since shortly after the sinking of the *Titanic* in 1912. The latest overhaul of these agreements is the International Convention for Safety of Life at Sea, 1948. This became effective in November 1952. The new Convention contains Chapter VI which concerns safe stowage. While its contents are rather general the reports supplement-

Improper stowage of common matches as part of a cargo of groceries resulted in a $100,000 fire at sea. Ship was not loaded under inspection of National Cargo Bureau.

ing the Convention indicate that further efforts to expand the regulations at international level may be anticipated.

In the United States, the responsibilities for implementation and enforcement of the International Convention rest with our Coast Guard. However, as in the case of the classification society, the American Bureau of Shipping, the Coast Guard has authority to utilize the service of a private agency for these purposes. This is exactly what the Coast Guard has done in the case of stowage of hazardous goods and bulk grain. It invited the shipowners and the ocean marine underwriters to adapt the former underwriters' inspection services to a new nation-wide, nonprofit agency, the certificates of which could be recognized as prima facie evidence of compliance with Coast Guard stowage regulations by shipowners. Incidentally, such certificates would presumably be (and subsequently have been) recognized by Suez and Panama Canal authorities.

National Cargo Bureau, Inc.

Shipowners and underwriters accepted the invitation. The result is National Cargo Bureau, Inc., a membership corporation founded in 1952 which offers shipowners a cargo-loading inspection service at almost every port in the United States.

Perhaps the two outstanding characteristics of this activity are (1) that shipowners, while required to comply with stowage regulations, voluntarily take the inspection; and (2) that National Cargo Bureau is a highly successful illustration of industry self-regulation in close cooperation with the responsible agency of Government.

How does National Cargo Bureau operate? At the present time the Bureau has 160 members, serving in their individual capacities, who are ship operators, marine underwriters, Government personnel, and men conversant with the interests of shippers and manufacturers of hazardous goods. A Board of 18 Directors includes the Commandant of the Coast Guard and the Maritime Administrator of the Department of Commerce. Policies and procedures determined by the Directors and several Committees are carried out by a small executive staff. The technical aspects are guided by an Operation Committee and the Chief Surveyor and are accomplished by approximately 60 surveyors at the many ports on all three coasts. Almost all of these surveyors have served many years aboard merchant ships and hold or have held the license of a Master Mariner. It is their function, in cooperation with the personnel of the ship operators and of the ships, to stow cargo as required by regulation and as safely as their knowledge permits. These men are thoroughly trained in the stowage of all types of cargo and are available to act in an advisory capacity to anyone requesting their services. Dangerous cargoes have increased in number so rapidly and the literature and regulations regarding them are so technical that most waterfront employees and ship operators have not the time nor the means to become specialists in dealing with their stowage.

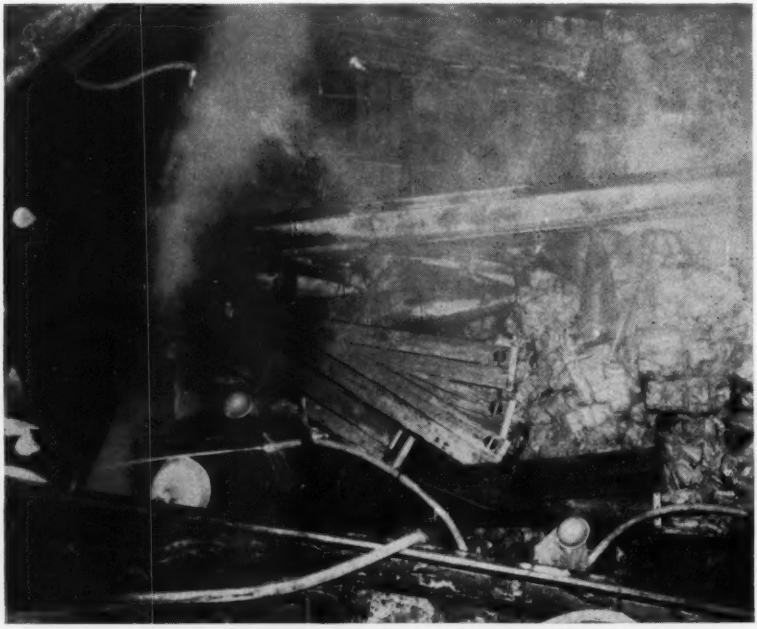
Duties of Bureau Surveyors

Before issuing a "Readiness to Load Certificate," the National Cargo Bureau surveyor inspects the cargo compartments to see that all debris is removed, and that the compartments are clean. Then he ascertains if any dangerous or hazardous cargo has been loaded at other ports, and, if so, that it is properly stowed.

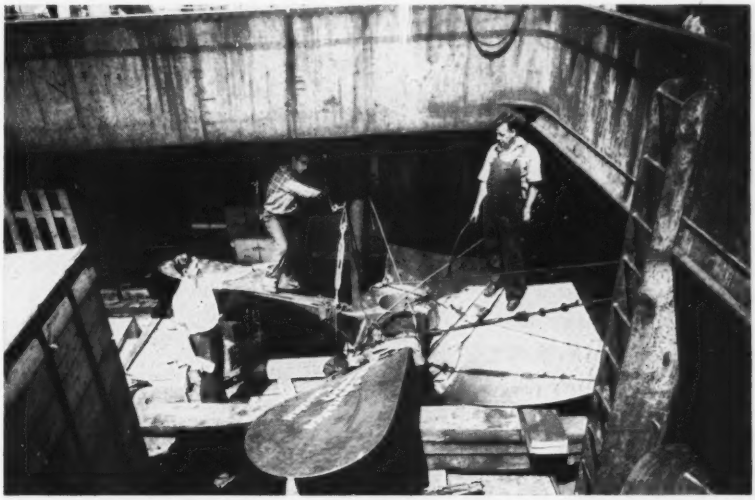
Prior to loading, the surveyor contacts ship's officers and the stevedore superintendent to check the amount and types of cargo to be loaded. He also suggests the desirable location and stowage, keeping in mind the hazard of fire.

Surveyors of National Cargo Bureau are always on the alert to avoid stowages which might involve the risk of fire. Coast Guard regulations, chemical dictionaries and other available information, including an enormous volume of card-indexed data accumulated over the years, are constantly consulted to insure the right stowage of a given commodity. For example, when flammable liquids or full cargoes of bulk grain are carried on a vessel, the National Cargo Bureau surveyor among other things checks the precautions taken to guard against fire and is particular about warning the ship's officers regarding drawing the fuses connected to electrical equipment in these holds.

In connection with all of this activity at the point of stowage, the National Cargo Bureau also makes recommendations to the Government regarding regulations to govern the stowage of hazardous goods, which the Government after approval promulgates. This is a serious and complicated task as one can tell by examining the book of regulations, covering 594 pages of fine print and approximately 1,800 commodities. Small wonder that



Several injuries to ship's personnel and damage estimated at $500,000 resulted from fire at sea when a cylinder of oxygen developed a leak due to working of the ship and cargo. Four violent explosions occurred among oxygen cylinders as the crew battled to save the ship. Vessel did not load under inspection of National Cargo Bureau.



Here a National Cargo Bureau surveyor inspects the lashing and securing of a 15-ton propeller stowed in vessel's upper 'tween decks.

the telephones in the Bureau's offices are busy all day with inquiries from dockside regarding the nature of many commodities and their safe stowage.

A guiding principle of the Bureau is this: regulation that is intended to prevent fires and to achieve safety-at-sea should not prevent the shipment of hazardous goods but should assist therein by describing the conditions under which the shipments can be made. And the function of the Bureau's surveyors at the ports is to assist ship operators to move goods safely.

Recommendations to Ship Operators

In addition to regulations that are promulgated by the Government, the National Cargo Bureau develops recommendations to ship operators and for the guidance of the surveyors. One of these recommendations concerns fire extinguishing apparatus on ships carrying cotton. Another applies to disconnecting blower fans in the ventilators of ships that carry gasoline or flammable liquids. And a third example is the Bureau's recommendation regarding fire prevention on ships discharging jute and burlap in U. S. ports. For instance, at New York, Boston, and all other U. S. ports every jute-discharging operation comes under the watchful eye of a National Cargo Bureau specialist. At least one potentially disastrous fire in New York harbor was cut short because fire hose had previously been laid out and connected ashore and because an alarm was quickly spread by the Bureau's specialist.

A National Cargo Bureau surveyor quickly acquaints himself with the characteristics of a ship that is under his inspection as well as with the ship's fire fighting equipment and the cargo already aboard and to be stowed aboard at that port. He not only knows the characteristics of the cargo, particularly the hazardous commod-

ities, but also he knows the location in the ship. For these reasons, in case of fire, he can be of invaluable assistance to fire fighters by advising them regarding the characteristics of the cargo, the location of goods, and the means of access to them.

Value of Preventive Actions

Successful fire prevention seldom provides the conclusive proof of the value of preventive actions. However, during the Second World War underwriters' surveyors were called in by one operation to plan all explosive magazines. One morning a surveyor discovered to his horror that on a ship which had previously carried sulphur, carpenters had started building magazines in all hatches. However, the ship had been poorly cleaned; there were small piles of sulphur all around the ship — on the deck beams, on the wood ceiling, and elsewhere. Although the surveyor pleaded with the superintendent in charge not to build a magazine until the ship was thoroughly cleaned, he was indignantly reminded that a war was on and that 8,000 tons of high explosives had to get on that ship and quickly. Well, rarely was a surveyor's judgment so quickly vindicated. At that particular moment, the carpenter foreman arrived on the run minus his eyebrows. A spark from a nail being hammered home had caused a flash fire which unfortunately had removed some hair and eyebrows, however, it did no other damage. The superintendent immediately ordered another ship fitted out while this vessel was cleaned up. The long and hard-won experience of the surveyor paid off handsomely in this instance.

Admittedly there are times when it is difficult to sell an intangible service, the fee for which might be $15 to $75. The surveyor is, in effect, selling a man the idea that because of his service the chances of the man's ship having a cargo fire perhaps two months and several thousand miles later are practically eliminated. Neverthless almost all ship operators in American ports are cooperating to maintain the low-cost, nonprofit, nationally uniform service known as National Cargo Bureau. It has the wholehearted cooperation of our Government.

Other countries as well as the United Nations Organization are increasingly interested in establishing some type of cargo-loading inspection service in other parts of the world. We in this country will welcome services that will bring safely stowed ships to our ports as we are trying to send safely stowed ships to their ports.

Steps in Developing an Industry Fire Policy

By Lowe H. Wiggers

The Procter & Gamble Company, Cincinnati, Ohio

The steps taken in developing Procter & Gamble's fire policy over the years seem to shape up in outline somewhat as follows:

1. Erection of the first Ivorydale factory in 1884.
2. Interest and cooperation of management.
3. Necessity for maintaining clean plants.
4. Study of causes of fires.
5. Prevention of losses.
6. Organization of plant fire brigades.
7. Inspections and audits.
8. Standards.

The Company's original factory, located in a downtown section of Cincinnati, was very largely destroyed by fire in 1884. Following the fire, a new plant named Ivorydale was erected about five or six miles out in the country. Large acreage was purchased and instead of having one or two multiple-story buildings, the plant was spread over a wide area and included numerous separate buildings.

At the same time, a huge reservoir for water storage was provided, with complete underground water system and all of the latest fire protection devices known at that time. In later years, as other plants were erected, the same general program was followed. In those cases where property already being used for similar manufacture was purchased, it was necessary to accept some multiple-story buildings, but in all such cases the risks have been divided into comparatively small fire areas, with adequate water and sprinkler protection.

That early lesson of the disastrous 1884 fire was a costly one. We believe that, most of all, it has helped us to remember at all times that fires do occur and that industry faces a never-ending battle to prevent them. This brings a determination to provide maximum protection to prevent fires, plus the use of up-to-date equipment and methods to extinguish them, or stop their spread if they do occur. Shops, warehouses, factories, refineries, mills, woodlots and forestry property all provide problems in fire protection and prevention. Somehow or other, however, fires do occur regardless of plans.

Isn't it strange that when we go camping or are trying to start a fire in the fireplace at home we sometimes work and work before we get a fire going, but some moron comes along and with a flip of the wrist, throws a lighted match or cigarette away which starts a fire which may burn for days!

Cooperation of Management

Recognition by owners and management of the fact that entire plants may be destroyed by fire we place in a position of primary importance. Without it no fire protection policy is worth its salt. At times it may seem difficult to obtain proper appreciation of this fact, but such recognition, once achieved, guarantees cooperation and sympathetic support of the organization's fire protection and fire pre-

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vention plans. Such an attitude may be developed the hard way, as a result of serious losses, inability to obtain insurance at reasonable rates or the knowledge that large contracts will be lost if serious fires occur. It may indeed be a case, obviously, of self-preservation to provide good protection.

After getting over the hurdle of wholehearted management interest, it is not difficult to obtain the cooperation and backing of development, engineering and manufacturing departments. The fact that top management gives concrete evidence that it wants no losses is almost a guarantee of cooperation from other departments.

Cleanliness

An important step was taken when we at Procter & Gamble were all sold on the value of cleanliness in plant operations. We have a clear recollection of what happened at some of our factories following a visit of the President of the Company many years ago. Some of our local manufacturing people thought that their plants were clean; but the President thought otherwise. He said flatly they were actually untidy—in poor shape from a cleanliness standpoint. The criticism seemed even more warranted when it was pointed out that, after all, "cleanliness is our business." The reaction was immediate and the improvement little short of miraculous. Today, throughout the manufacturing and administrative organization, we regard the maintenance of *a clean plant* as a basic step in developing a fire policy.

Causes of Fires

Another important step is the study of the causes of fires. A record is kept of every fire loss regardless of size. The record includes a report of investigation with all the facts available. A study of these reports gives a clear picture of what to look for or what to do to prevent other losses under similar or related circumstances. It may be found that certain waste material is not being removed from a department quickly enough. It may be

The original Procter & Gamble factory which was located in downtown Cincinnati. In 1884 fire practically destroyed this building.

that one person in the department is being careless without realizing it. A loss may be caused by improper care of equipment or a careless attitude on the part of a supervisor. Any fire protection engineer is aware of the causes of many fires. We want to know the facts in back of fires which have occurred in our plants. This is a must. Then, in addition, the current fire reports and statistics published by the National Fire Protection Association are studied, to compare our experience with that of other plant operations.

In any manufacturing plant some of the causes of fires are at times fantastic and again we find a fire has been caused by a combination of four or five things happening in consecutive order, with the final incident causing the damage. For example, on one occasion we were installing a new process which included an oil heating system. The plans called for a circulating system somewhat similar to a hot water system with an overflow tank at the top of the system, as used in homes. It just happened that the construction foreman's desk was located directly under the tank. The new system had been started and then the plant shut down over the weekend and the weather turned cold. The cold weather caused the oil in the lines to harden. Later, when steam was used, there was a surge of hot oil and it ran out of the overflow tank. As the oil hit the air it touched a lighted electric light bulb which broke and ignited the oil. The oil fell on the desk, around which a group of men were standing waiting for instructions for the day's work. The resulting fire was serious in itself, but the loss of several lives was tragic. In retrospect it seemed self-evident that the overflow tank should have been outside of the building; that the foreman's desk should not have been located near the tank; and that if the weather had not turned cold it would not have been necessary to use steam to thaw the lines, and therefore, that there would have been no fire and no loss of life. Despite the unpredictable factor of weather, however, it seemed plain that better planning might have prevented this fire. It was a costly lesson, not forgotten 30 years after.

There have been times, too, when we learn a very serious lesson the funny way.

Another piece of forest fire fighting equipment.

This is the type of equipment used for fighting fires in forest lands in Florida.

At one of our mills during the busy cotton seed unloading season, a man was hired to watch the elevator bin and make sure that it wouldn't become choked with seed. This was on a night shift, and, as sometimes happens, this watching became monotonous and the new employee fell asleep. The elevator became choked with seed. The friction from the belt on a pulley set afire some of the cotton lint which forms a fuzz on the surface of each seed. The heat from the fire set off a sprinkler head and water extinguished the fire. An alarm gong very properly went off, awakening the man who was supposed to be a watchman. He ran through the mill yard for the foreman, yelling "Boss, there's a bell ringing down yonder! What does I do now?"

On another occasion (don't ask me why) a man was carrying a bucket of gasoline which he set down on a bridge extending between two buildings. In the meantime, another man was working with some hot metal. He wanted to cool off a rather hot piece quickly. He started to run toward the outside of the building but when he saw the bucket of what he thought was water, made a dash for it. Fortunately, at the last instant, someone saved him.

On another occasion, fire occurred in cotton seed stored in a group of steel tanks at one of our southern plants. For some reason fire got into one tank and before it was extinguished, seed in a second tank was ignited. A lot of water and two days' time were needed to extinguish that fire. As a result of that fire, steps were taken to study the storage of cotton seed and similar combustible products. Following this, air-cooling and control systems were installed in tanks and houses used for storing seed.

This fire, and similar ones at other locations through the cotton country, had the practical effect of requiring companies storing vegetable-oil products to do a great deal of research work. Such studies, made over 25 years ago, were very effective in helping us reduce the risk of fires like these. They contributed in a very important way toward the development of our Company's fire policy.

Losses are never pleasant, but do teach us lessons; because by studying them we are able to determine what we are doing that is wrong. Back in 1928, fire occurred in one of the tile silos at Ivorydale. The silo, about 50 feet in diameter by 60 feet high, contained 2,000 tons of copra. Copra is the dried meat of the cocoanut and contains about 63 per cent oil. Fire was caused by a short circuit in electric wires, igniting oily copra dust which had been permitted to accumulate around the top of the silo. Had the wiring been in conduit, the source of ignition would have been eliminated. If the top of the silo had been clean, fire could not have gotten into the silo. So we learned two lessons the hard way. First, electric wiring should be placed in conduit and second, all of a factory should be kept clean.

The study of the causes of fires is time consuming, but rewarding. It is unfortunate that in too many cases we must use our bad experience as a primary guide in building up a fire policy.

Prevention of Losses

In a large company, changes and additions are constantly being planned and made. In our Company, the general management is in the hands of an Administrative Committee which authorizes expenditures and establishes Company

policy. The Insurance Manager is given a copy of Committee authorizations covering new developments such as additions to plants, new plants, changes in processes and matters of similar nature.

For example, one resolution may authorize a substantial sum of money to provide facilities necessary to effect the combination of several laboratories. The next item may cover a large appropriation to cover the installation of a new production line at one of the factories. The next resolution may include an appropriation for increasing the capacity of a plant to provide for the production of a new product. Resolutions of this kind represent approval of recommendations which are prepared by manufacturing and technical departments of the Company. In the preparation of these recommendations, the Insurance Department, of course, has contributed advice as to fire safety equipment, water supply, and so on.

Following authorization of the project, the study of fire protection is carried through by contact between the proper manufacturing and engineering personnel and the Insurance Department until the construction work has been completed. In addition to the fact that the Insurance Department is responsible for seeing that all insurance requirements are complied with, the various steps taken in the interests of fire safety during engineering and construction stages provide basic information with which to work out the permanent fire protection plans for the new project after it is in day-by-day use.

Along the way, various departments and individuals are brought into the picture so that everyone understands, insofar

Exhibition and tests given by industrial and municipal fire departments.

Typical pieces of detecting apparatus are demonstrated at one of the factories.

as possible, what risks we are up against. Starting at the beginning, of course, we must consider the fire and explosion risks and plan accordingly. These plans may include additional water supplies, special types of extinguishers, sprinklers, etc.

Another step in fire protection which we deem important is the matter of holding down fire areas. We know by experience that fire walls form an effective barrier against spread of fire and it has been our practice to hold fire areas to a minimum.

In all projects involving new or increased plants and facilities we have found no substitute for sitting down with the chief engineer or his associates and with insurance company engineers and studying the fire safety situation from scratch. Such a study concerns first of all the prime problem of safety to employees. It concerns, too, fire protection, insurance requirements and the matter of low rates for insurance. To cap all of these comes production, which must be efficient and profitable, or there is no excuse for the new factory or process.

Private Fire Brigades

Up to this point I have said nothing about plant fire brigades. Certainly, they are important in our organization. A factory with a one source water supply, no standpipes and only city hydrants with public fire department to rely on is an entirely different type of risk than a plant with two or more sources of water supply. The first risk may have no plant fire brigade because there is little for a fire brigade to do, but the second risk may have numerous plant fire brigades. The application of systematic steps in fire prevention and of planned fire protection methods remains constant. The plan calls for a clean factory, good watch service, personnel alerted to fire hazards and trained in fire prevention, and reasonable fire divisions.

As an example, one of the largest Procter & Gamble factories is divided into 17 fire areas with a fire brigade in each area in addition to a central department with a fire chief and about 50 men. In each area fire brigade there are approximately 10 men, with one man as Chief. Those men in the nonhazardous areas are given about two hours training every three months. For men in the hazardous areas, the training consists of approximately two hours every two months.

As the men in a brigade are brought together, the fire chief and his assistants follow a more or less standard program which includes discussion as to "why have an area fire brigade" and "what good it does for the individual." The hazards in each particular area are explained to the members of the brigade and with the practical training they get to know what to look for and what to do if there is an emergency. At this particular plant there are two pumpers, plus an ambulance with two-way radios. Regular drills are held not only inside the departments, but also out at a drill ground.

The central department, consisting of 50 men, is divided into five groups of 10 each and each group receives four hours training per month. The fire chief is the key figure in this program and he and his assistants are dedicated to their work. They are enthusiastic and well trained and command the respect of the palnt organization.

At the small plants too, brigades have been organized and repeated tests show that the men respond to an alarm and have hose connected or extinguishers ready to use in a period of from 40 to 80 seconds.

Needless to say, we consider the organization, drilling and maintenance of fire brigades as an extremely important and necessary step in developing a fire policy. Men are human and naturally mistakes are made at times, but we are well aware of the value of these plant fire brigades.

In all of the steps taken, we never lose track of the city fire departments. It is both good policy and a vital step in planned fire protection to have the local city fire department representatives visit factories frequently in order to familiarize themselves with the plants. I cannot stress too strongly the importance of this in developing a sound fire policy. The city fire department is our shelter in time of storm.

Inspection

In our Company, we have men who make inspections of the various plants. These inspections are similar to those made by the insurance companies, but we believe are more exacting because our men are familiar with the hazards existing at the factories and are better able to talk out and review in detail matters which do not look right. Following these inspections a written report is prepared and where conditions justify it, the report includes recommendations for elimination of defects. These reports are edited in our department, submitted to the Administrative Vice-President, with copies to the President and Chairman of the Board. Other copies go to manufacturing departments, including the local plant management. Each item is followed up until it is given attention.

In addition to these inspections, self-inspections are made daily and weekly. Interruptions to fire protection, such as broken lines, sprinkler impairments, or new work being done, require special telegraphic notices to our department at the time the interruptions start and a second notice when the defects have been corrected. This particular program has been in effect for many years. We consider it one of the important and necessary steps in developing a sound fire policy, as well as a vital requirement in stressing throughout the organization the importance of never-ceasing fire watchfulness.

For warehouses, office buildings or scattered risks in which we may have an interest, our fire policy calls for good cleanliness, watch service, good protection as far as possible and plenty of insurance.

Standards

All of the principles I have outlined and the points I have made, which we consider important in an industrial fire policy, are outlined in our Company standards which are prepared for the different departments of the business. Keeping these standards up to date, coordinating their observance and looking after their constant improvement requires the active interest of the executives of the Company,

The chief of one of the plant brigades directs his men during one of the frequent drills and tests which are held at all plants.

division superintendents, plant superintendents, fire protection men, and the watchmen. Sound methods of fire protection must go all the way: they must have the concern of everybody, from the local fire protection man and watchman at a plant, right up to the Chairman of the Board. It is the active interest of all of these men which tops off the development of an industry fire policy and helps to make it effective.

To Summarize

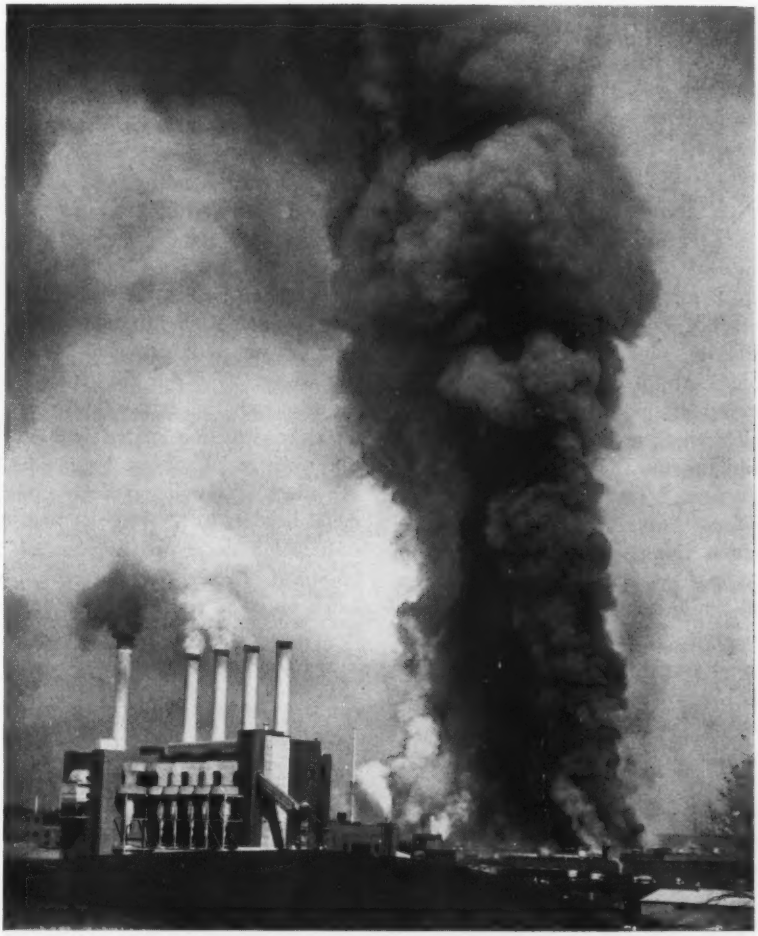
Every time we have occasion to review the development of our Company's fire policy we are once again startled at the many steps that are taken, and the many persons who have a part in supporting the work. Certainly it is not a one-man effort or a one-department project. The steps we have taken at Procter & Gamble in developing our fire policy have involved

—constant interest and wholehearted support of top management;
—a conviction that our plants must be kept clean;
—a continuous study of the causes of fires in our business and in other places;
—definite, up-to-date technical steps to prevent fire losses;
—organization of plant fire-prevention and fire-fighting brigades;
—regular inspections and audits; and written standards for every department.

In this outline of procedures we claim nothing new or radical. We do believe, however, strongly, that the problem of fire prevention is one which fully deserves all of the management interest and attention our people give it. And for those of us who are actively in the day-by-day work, the problem is one which can challenge the best that is in us.

Front Royal Rayon Plant Fire

By Miles E. Woodworth, NFPA Flammable Liquids Engineer



Winchester Evening Star

On May 12, 1955 at the Front Royal, Virginia, plant of the American Viscose Corporation a flash fire swept from the rayon continuous spinning department through approximately 1,000 feet of plastic lined combustible duct located on the plant's roof causing an estimated $1,500,000 loss to the building and contents. The fire probably was caused by a cutting torch being used on the second floor of the building during repair operations to one of the

machines. Sparks from the cutting operation ignited oily deposits on the ceiling and in drip pans on the first floor. The flames severely damaged the adjacent machine since the fire was drawn through its exhaust duct system which was not equipped with automatic sprinklers.

Description of Building

The Front Royal plant consists of several connected buildings covering a large area located within the city limits of Front Royal, Virginia. Production of rayon fibres was started in 1940 but since that time several new buildings and processes have been added. Approximately 50 double deck continuous spinning machines were installed three or four years later. The buildings are mostly equipped with automatic sprinkler systems and are of fire-resistive construction. The continuous spinning department was not equipped with automatic sprinklers, and the building was of concrete construction with the second floor being supported by large steel I beams.

In the double decked rayon spinning machines viscose is pumped through spinnerets on each machine and from there passes through an acid bath, is washed, treated with soap finish, and then passes through to the first story over steam-heated dryers and is wound up on cones.

The waste fumes driven off from the acid and drying processes are not only flammable and toxic but also are very corrosive due to the acid fumes. It is, therefore, extremely important that an adequate ventilation system be installed which is provided by a battery of six 200,000 CFM fans. From the machines the exhaust ducts are of metal construction coated with corrosion-resistive plastic on both sides of the duct through similarly treated metal headers to the large combustible constructed ducts on the roof of the buildings. These large overhead exhaust ducts on the roof were only re-

Arrow points to duct where fire was first discovered.

cently installed for the continuous spinning department and prior to this time underground exhaust ducts were utilized. However, additions to the plant caused the overhead duct system to be installed. These large exhaust ducts on the roof were supported on steel frames and lined on the inside with a "slow burning" plastic applied to plywood. The outside was covered with corrugated cement asbestos board.

A similar type exhaust system on the roof for another section of the plant was installed which paralleled the duct from the continuous spinning department. An emergency cross connection was made between these two ducts which would enable either system to be utilized in the event one was shut down. Fire spread through the cross connection and involved the paralleling duct system.

Oil leakage from the machines resulted in oily deposits on the ceiling of the first floor. In order to catch these drippings, aluminum drip pans were installed which covered a large area of the ceiling. Drip pans also were installed on the machines themselves, wherever possible, to catch and collect oil drippings.

The Fire

The first knowledge of the fire was by one of the workmen on the roof who saw the plastic on the outside of one of the metal branch ducts burning and immediately turned in the alarm. The plant fire alarm was sounded at approximately 8:20 A.M. At 8:25 A.M. the Chief of the Front Royal Police Department saw the smoke from the fire and immediately drove to the plant. At 8:26 A.M. he radioed back to bring all available fire equipment and at 8:27 A.M. the town fire alarm signal was sounded.

When the Chief of Police arrived at the gates the guards were unaware of the fire in the plant but as he drove into the property, people were just coming out of the buildings. Although he saw no hose lines in operation, the plant fire brigade was undoubtedly operating from hose houses located on the roof. He broke open several locked hose houses and guided the Front Royal Fire Department to a location where they could lay in long lines over the roof of the buildings to the fire in the ducts.

The Front Royal Fire Department had 49 men at the fire, which included those members of the Department who were also members of the Viscose Corporation's fire brigade. When the Chief of the Fire Department arrived, he called for help from the towns of Strasburg, Luray and Winchester. The Strasburg Fire Department had twelve miles to travel and responded with one pumper as did Luray, which had twenty-four miles to travel. The Winchester Fire Department sent two pumpers the twenty miles to Front Royal. The Front Royal Fire Department had responded with three pumpers, one of 750 gpm capacity and two of 500 gpm each.

The fire was under control by 9:30 A.M. The Strasburg Fire Department was the only other fire department to use a hose line, although the Luray Fire Department laid in a 2½-inch line which was not charged. The Winchester Fire Department upon arriving and seeing that the fire was under

control, took their equipment into Front Royal to cover the rest of the town in the event of another fire occurring.

Despite the apparently intense fire on the interior of the building caused by the burning of the oily deposits on the ceiling of the first floor and in the drip pans as evidenced by destruction of the aluminum drip pans and one machine plus the distortion to the steel I beams, the fire did not spread horizontally on this floor. The large capacity duct system, exhausting approximately one million cubic feet of air a minute, was able to draw the original fire from the oily deposits up through the exhaust system. No fire fighting was necessary on the interior of the building except with a 1½-inch line which was used to extinguish small fires on the machines long after the fire was under control. Although the fans were destroyed approximately ten minutes after the fire was discovered, they undoubtedly served their purpose by keeping the fire confined to one area and thereby permitting the safe evacuation of all the plant personnel. The lining of the sheet metal ducts and the combustible ducts on the roof were soon consumed in the fire. The Chief of the Front Royal Fire Department felt that the ventilation provided by the burned out duct work and by the fire department opening up other ducts was the material factor in keeping the damage at a minimum.

"Slow-burning" plastics are generally recognized as being flame resistant since these materials will burn only when flames are continuously applied and will cease to burn when the flame is removed. In the use of plastic in the large capacity duct system, the original fire was of such intensity as to spread the fire very rapidly throughout the duct system. The plastic lining burned very quickly, exposing the plywood to which it was applied and the plywood added more fuel to the fire. The corrugated asbestos board covering the outside of the ducts shattered like glass from the heat. The heat and intensity of the fire in the duct system was evidenced by the failure and destruction of each of the 200,000 CFM fans within ten minutes of the fire's discovery.

The plant's fire pumps maintained an adequate water supply throughout the fire and there was never a shortage of water throughout any of the fire fighting operations even though there were at least twelve 2½-inch lines being used.

Since the NFPA representative did not secure permission to visit the plant, information was not available on the organization of the plant fire brigade but from all reports they did a very creditable job. Their fire fighting would indicate that there must have been at least weekly drills as at other American Viscose plants. As in most cases where management is not prepared for a fire of as widespread interest as this one was, press relationships were unfortunate. To quote the Associated Press, "American Viscose officials clamped a tight security guard on the damaged portion of the plant, barred photographers and declined to answer questions."

Conclusions

Ducts should be of noncombustible construction. (See NFPA No. 91, Blower and Exhaust Systems.) Non-

Typical destruction of exhaust duct from the double deck spinning machine.

combustible corrosion-resistant linings are recommended also. Since flammable vapors are handled in these exhaust systems, a well-designed, approved, fixed pipe system for the application of water is recommended.

Sub-division of the large exhaust systems would have prevented the fire from spreading to other sections of the plant.

The installation of automatic sprinklers in the continuous spinning department would seem to be indicated.

Preventive measures should be taken to stop the oily deposits on the ceiling of the first floor and eliminate the necessity for the large drip pans.

If welding or cutting operations are being conducted, adequate fire guards should be posted on the floor below where the cutting operations are being conducted when the possibility exists of sparks dropping through to the floor below.

The development of a disaster plan in cooperation with municipal officials is recommended. Such plans have been proven extremely valuable to industry in other locations under similar circumstances.

Acknowledgment

The NFPA expresses its appreciation particularly to Chief Frank A. Stoutamyer of the Relief Fire Department, Front Royal, Virginia and to Chief Raymond Beeler of Strasburg, Chief Taylor Barr of Winchester and to Chief Lohr of Luray as well as to the members of their departments interviewed. Chief Menefee of the Front Royal Police Department was equally cooperative in supplying details for this report. Also appreciated were the photographs from the *Winchester Evening Star* and the *Warren Sentinel* of Front Royal.

A Dry Chemical Extinguishing System

By Arthur B. Guise and James A. Lindlof

Ansul Chemical Company, Marinette, Wisconsin

The fire extinguishing effectiveness of dry chemical applied from hand portable extinguishers and hose lines made the development of systems using fixed piping almost inevitable. A few systems were installed in the late 1930's but each was tailor-made by actual cut-and-try tests to fit the protected hazard and the older type coarse dry chemical of inferior fire extinguishing effectiveness was used. Before dry chemical extinguishing systems could become practical, it was necessary to obtain information permitting the design of such systems in the same way that water spray systems and carbon dioxide systems are designed.

Dry chemical, being a powdered solid, must be properly fluidized by gas aeration before it will flow. However, when properly fluidized, it may be treated as a gas or liquid except in certain special respects. When discharged from a nozzle, it acts somewhat like a liquefied gas because of the expansion of the compressed gases.

The problems involved in the development of a dry chemical system were to determine the pressure drop in pipe and hose, to determine the considerations involved in the proper distribution of the dry chemical, to determine the rate of flow through orifices, to formulate the requirements for the extinguishment of fires by local application, such as for dip tanks, and to determine the requirements for the extinguishment of fires by total flooding.

Fluidizing the Dry Chemical

Control of the flow of dry chemical starts at the dry chemical container. The fluidizing and pressurizing gas (nitrogen or air) must be admitted to the tank in such a way that the dry chemical is properly fluidized while the pressure builds up equally throughout the entire volume of the tank. Should the pressure increase too rapidly above the dry chemical, the powder will not be properly fluidized, the pressure drop in the piping will be excessive and the rate of flow will be too low for proper fire extinguishing effectiveness. Should the gas channel to the outlet before the top of the tank is properly pressurized, the ratio of gas to dry chemical will be high, the rate of flow of dry chemical will be too low and again the fire extinguishing effectiveness will be greatly reduced. Accordingly the design of the means for admitting gas into the dry chemical container is fairly critical if consistent and optimum fire extinguishing effectiveness is desired.

From the foregoing description, it is obvious that it is desirable to build up pressure in the dry chemical container before the dry chemical is released into the piping. This may be achieved by several methods, but in the system described here it is done by the use of a bursting disk designed to rupture at 165 lb. per sq. in.

This talk was presented by Mr. Guise at the 59th NFPA Annual Meeting held May 16-20, 1955 in Cincinnati, Ohio.—Ed.

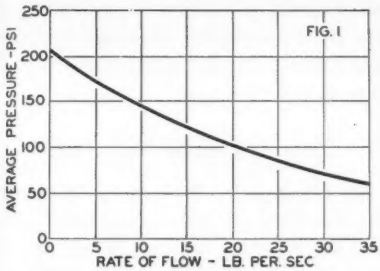


Figure 1. Variation of the rate of flow of dry chemical with variation in the discharge pressure at the outlet of the dry chemical container.

The outlet pressure from the dry chemical container, however, varies according to the rate of flow as shown by Figure 1. This relationship is taken into consideration in the design of a system.

Factors in Design of Piping

The use of standard pipe and fittings for carrying dry chemical is not as simple as it first appears. Dry chemical, being carried by gas at high velocities through the pipe, is thrown to the outside by centrifugal force when it passes through an elbow. Should the elbow be directly connected to a tee and be in the same plane as the tee it is obvious that from one run of the tee will issue a stream containing a high proportion of dry chemical to gas and from the other run of the tee will issue a high proportion of gas to dry chemical. This condition is overcome by insuring that the connection of an elbow to a tee is made with the plane of the elbow perpendicular to the plane of the tee, or by allowing a sufficient length of straight pipe to insure that the gas and dry chemical are redistributed before they enter the tee.

Before the practical design of a dry chemical system could be accomplished, it was also necessary to know the pressure drop in standard pipe and fittings at various rates of flow. These data were obtained by making a large number of tests with a range of flow rates and a range of sizes of standard pipe and fittings. The results for pipe are shown by Figure 2.

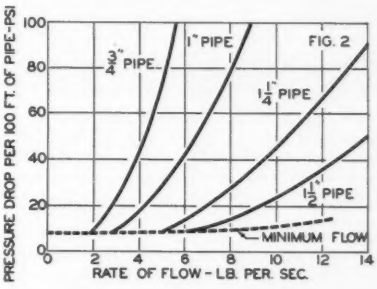


Figure 2. Pressure drop in different diameter pipes with variation of the rate of flow of dry chemical. Rates of flow less than those indicated by the dotted line are not advisable because of the tendency of solid particles to separate from the stream of gas at lower flow rates.

It will be noted that there is a line marking the minimum advisable flow rate for each size of pipe. The minimum flow rate is determined by the velocity of the fluidized dry chemical in the pipe. Below these minimum rates the solid particles tend to separate from the stream of gas, causing a surging flow from the nozzles.

It was found that the pressure drop through an elbow is equivalent to the pressure drop through 20 ft. of straight pipe of the same size. Also, the pressure drop through a tee is equivalent to that of 45 ft. of straight pipe of the same size.

We wish to emphasize that the foregoing quantitative data are applicable only when the ratio of dry chemical to gas is a certain predetermined value. Figure 3

indicates the difference in pressure drop obtained with one size of pipe when the ratios of dry chemical to gas are changed. Accordingly, the data given in this paper are applicable only to those dry chemical systems having substantially the same ratios of dry chemical to gas.

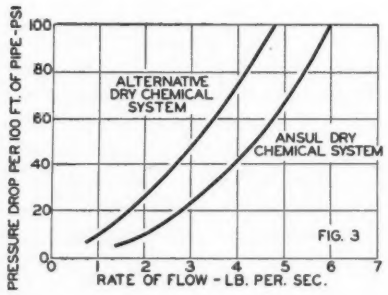


Figure 3. Effect of ratio of dry chemical to gas on pressure drop in ¾-in. pipe.

Nozzles

The final step in obtaining fundamental information was to determine the rates of flow of dry chemical through orifices at a range of pressures. The practical application of these data to the nozzles used in the fire tests to be described is shown by Figure 4. It will be noted that for any given nozzle pressure a size 2 nozzle has twice the rate of flow of a size 1 nozzle and a size 3 nozzle has twice the rate of flow of a size 2 nozzle.

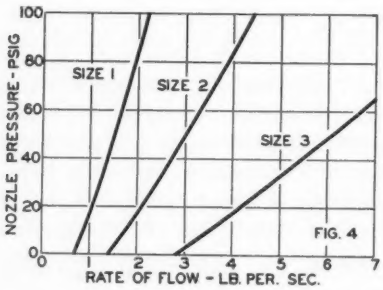


Figure 4. Variation of rate of flow of dry chemical from nozzles with variation in nozzle pressure.

Local Application Fire Tests

In running the fire tests to determine the standards for local application, gasoline was invariably used as the fuel. Tests were made on fire areas of 7½ sq. ft. to 300 sq. ft., all of which were in steel sided test pans except for the 300 sq. ft. area. A 2-in. depth of gasoline was used with a freeboard ranging from 6 in. to 11 in. depending on the nozzle arrangement. The preburn times for most of the fires were between 10 sec. and 15 sec. although other test fires were made with approximately one minute preburn to determine the effect of long preburn times. To extinguish the fires with longer preburn time required approximately 10 per cent more dry chemical.

In all except one case, the test pans were square. There were two 100 sq. ft. test pans, one being square and the other round. It required approximately 20 per cent less dry chemical to extinguish a fire in the round pan than in the square pan.

All fire tests using tankside nozzles for local application of dry chemical were run outdoors with wind conditions up to 24 miles per hour.

Two arrangements of nozzles were used, one in which the nozzles were placed at the side of the tank and the other in which the nozzles were located overhead. One type of tankside nozzle is similar in appearance to window sprinklers and throws a flat stream of dry chemical over a wide arc. Others are designed to form a thicker, narrower stream having a higher velocity to reach farther

over the fire area. The overhead nozzles have a considerably higher velocity and the dry chemical streams are cone-shaped.

Figures 5, 6, and 7 show a test with the 300 sq. ft. gasoline fire area with tankside nozzles. Pails acted as obstructions.

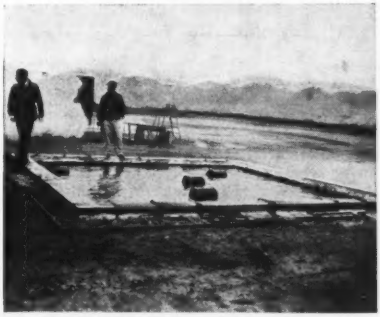


Figure 5. This 300 sq. ft. test area was one of several test areas of different sizes and shapes used to determine standards for a local application dry chemical system. The pails were used to simulate obstructions to distribution.

Effect of Application Rate on Time to Extinguish

It was found that the rate of application of dry chemical was critical in certain ranges. Specific relationships between quantity, rate of flow, and time of extinguishment were found to hold true over the wide range of fire areas used in these tests. It is believed that this relationship has much wider application and accordingly we are presenting the information in some detail.

In 1949, in connection with a study of the combined use of foam and dry chemical, we made tests to determine the effect of varying the per cent of foam solution on the quality of mechanical foam as judged by its effectiveness in extinguishing gasoline fires. It was found that the

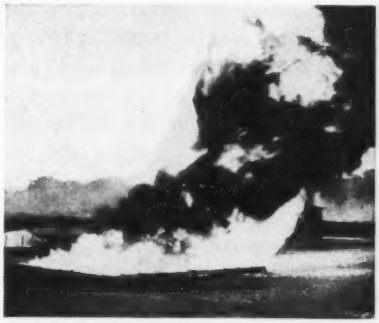


Figure 6. A 2-in. depth of gasoline with a freeboard of 6 in. to 11 in., depending on the nozzle arrangement, was used in the local application tests. This photo was taken of the 300 sq. ft. test area during the preburn.

Figure 7. This photo of the 300 sq. ft. test area shown in Figures 5 and 6 was taken after the fire had been extinguished by dry chemical discharged from a system of tankside nozzles.

relationship between the time to extinguish and the rate of flow may be expressed by the hyperbolic equation:

$$t = \frac{aR}{R-b}$$

in which t = the time to extinguish
R = rate of application, and
a and b are constants

The curve derived from the data is shown by Figure 8.

Confirmation of the existence of this relationship is readily obtained by plotting the reciprocal of the rate of application against the reciprocal of the time to extinguish. If the points lie in a straight line, the relationship may be expressed by the foregoing equation.

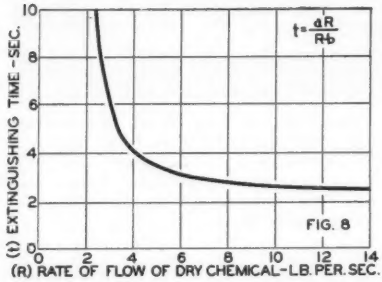


Figure 8. Variation of time required to extinguish a 50 sq. ft. test fire with variation of the rate of flow of dry chemical. The same mathematical relationship represented by the hyperbolic curve has been found to hold true for many extinguishing agents.

Since the rate of application is equal to the quantity of material (Q) used to extinguish the fire divided by the time to extinguish, another mathematical relationship is expressed by the equation:

$$Q=\frac{aR^2}{R-b}$$

This relationship is shown graphically by Figure 9. It will be noted that for a given fire condition and a given method of application there is a minimum quantity of extinguishing agent required and this is found at only one application rate.

The constants a and b varied according to the size of the test fire but did so in a way which allowed the establishment of an overall mathematical relationship of the minimum quantity of dry chemical required to extinguish a fire, the rate of application, and the size of the gasoline fire. This overall mathematical relationship for dry chemical is described by the equation

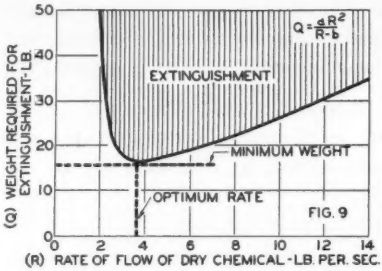


Figure 9. Variation of the quantity of dry chemical required to extinguish a 50 sq. ft. test fire with variation of the rate of flow. The graph shows that for a given set of test conditions there is an optimum rate of flow at which a minimum quantity of dry chemical will be required for extinguishment.

$$Q=\frac{cA^{0.5}R^2}{R-dA^{0.75}}$$

in which A is the area of flammable liquid surface and c and d are constants. Figure 10 shows graphically the relationship after the design safety factors have been applied.

At less than the optimum rate of application the required amount of extinguishing agent very rapidly increases. It will also be noted from Figure 9 that as the rate of application increases beyond the optimum, the required amount of extinguishing agent slowly increases. This phenomenon is probably due to what may be called "wastage" of dry chemical.

As a matter of interest, similar mathematical relationships between the time to extinguish and the rate of application have been found to hold true for many extinguishing agents other than dry chemical and foam. We believe that this can form a valuable tool for the accurate eval-

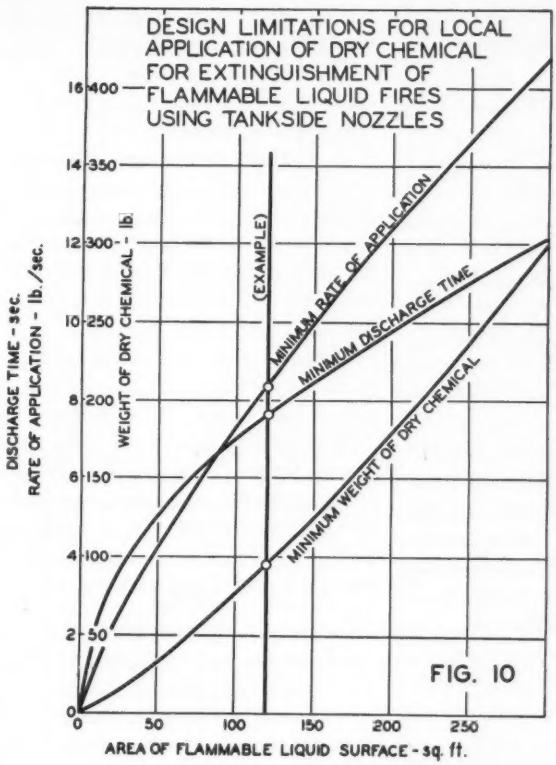

DESIGN LIMITATIONS FOR LOCAL APPLICATION OF DRY CHEMICAL FOR EXTINGUISHMENT OF FLAMMABLE LIQUID FIRES USING TANKSIDE NOZZLES
DISCHARGE TIME - sec.
RATE OF APPLICATION - lb./sec.
WEIGHT OF DRY CHEMICAL - lb.
AREA OF FLAMMABLE LIQUID SURFACE - sq. ft.
(EXAMPLE)
MINIMUM RATE OF APPLICATION
MINIMUM DISCHARGE TIME
MINIMUM WEIGHT OF DRY CHEMICAL
FIG. 10

Figure 10. The mathematical relationship of the minimum quantity of dry chemical required to extinguish a fire, the rate of local application, and the size of the fire are shown here graphically.

A design safety factor of 100 per cent was applied when drawing the graph.

The vertical line (example) refers to the example discussed on page 59.

uation of extinguishing agents and methods of application. The use of this method will also allow accurate determination of the quantity of extinguishing agent needed for various flammable liquids.

Total Flooding Fire Tests

Tests to determine the concentrations of dry chemical necessary to extinguish flammable liquid fires by the total flooding method were made in a building having a volume of approximately 8,400 cu. ft. It was quickly found that with larger test fires and longer preburns less dry chemical was required to extinguish the fire. Accordingly, a series of tests was run to determine the worst fire condition. For a given volume, the effect of the size of fire is shown by Figure 11.

By halving and quartering the building, it was possible to make flooding tests with three volumes and obtain a general relationship. It was found that the rate of application was not as critical as in extinguishment by local application but that too low a rate of application could result in failure to extinguish a fire. It was also found that, with the nozzles then in use,

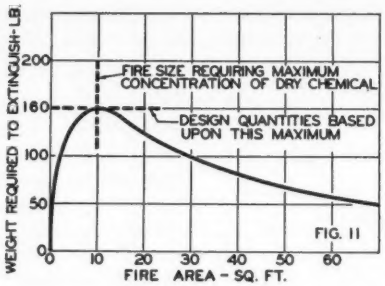


Figure 11. Extinguishment of test fires by the total flooding method showed that the quantity of dry chemical required decreased as the size of the test fire increased. Design quantity is twice the minimum quantity of dry chemical to extinguish the fire.

misalignment at extreme spacing could result in failure to extinguish. Closer spacing resulted in extinguishment even with extreme misalignment. Flooding nozzles direct streams in horizontal directions as well as directing a certain proportion of the dry chemical downwards. This arrangement, it was found, provided the most satisfactory flooding method with dry chemical.

To test that dry chemical diffuses to all spaces within the protected volume, tests were run with a variety of obstructions such as piles of pails and drums. Pails of burning gasoline were also placed at various levels and at various locations within the building. With proper design of the dry chemical flooding system, no failures to extinguish were found.

Minimum Design Standards

After over 1600 separate flow and fire tests using over 300,000 pounds of dry chemical, it was possible to establish conservative standards for the installation of dry chemical piped systems. Because there was no information available as to the safety factors incorporated in existing NFPA Standards on other extinguishing systems, it was arbitrarily decided to use a 100 per cent safety factor on both the quantity of dry chemical required (as established by fire tests) and the rate of flow. From the relationship between the required quantity of dry chemical and the rate of flow, an area of safe design for installation was established. The minimum design flow rate for local application is twice the median minimum flow rate, the maximum design flow rate is one-half the median maximum flow rate, and the minimum design weight of dry chemical required for an installation is twice the median quantity determined to be necessary by fire test. The area of safe design for total flooding with dry chemical has no upper limit on the rate of application because there are no indications that a very high rate of application is harmful.

Graphically, these areas of safe design are shown for local application by Figure 12 in which fire test data are expressed in terms of the percentage of minimum design weight and percentage of minimum

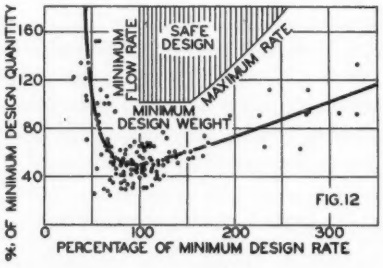


Figure 12. Minimum design standards for rate of application and quantity of dry chemical when applied by local application.

Dots locate successful tests expressed in terms of percentage of minimum design weight and percentage of minimum design flow rate.

design flow rate. For total flooding the area of safe design is shown with the fire test data by Figure 13. Statistical analysis of the data indicates that the probability of requiring as much as the minimum design weight of dry chemical for extinguishment is only one in 100,000.

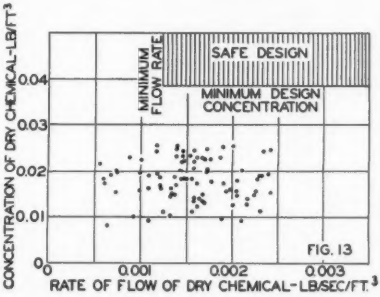


Figure 13. Design standards for rate of application and required quantity of dry chemical when applied by the total flooding method.

Although by using the pressure drop data it is possible to design what might be called an "unbalanced dry chemical piped system" it is generally easier to use a balanced system of 1, 2, 4, 8, 16 or 32 nozzles. Even so, the computations for such a system are involved because the variables are nozzle pressure, rate of flow, pressure drop, and tank outlet pressure. Figure 14 shows the type of chart used to simplify the calculations. An example of the procedure used in designing a dry chemical system for the protection of a dip tanks follows.

Example — Protecting a Dip Tank

Using 120 sq. ft. as the area of the flammable liquid in the dip tank, refer to Figure 10 where it will be noted that for this area the minimum design weight of dry chemical is 94 lb., the minimum design rate of application is 8.3 lb. per sec., and the minimum design discharge time should be 7.5 sec. The capacity of the smallest listed dry chemical system unit is 150 lb. and accordingly this would be specified for the protection of this tank.

After determining the proper placement of the correct number (eight in this case) of nozzles, the arrangement and size of piping for conducting the dry chemical to the nozzles is planned and the total effective length to the farthest nozzle is determined. From this information, the pressure drop is calculated at an assumed base flow rate of 12 lb. per sec. and in this case found to be 146.3 lb. per sq. in.

Using Figure 14, the calculated total pressure drop of 146.3 lb. per sq. in. is plotted on the vertical index line on the left side of the graph. Through this point a line is drawn parallel to the pressure drop slope line. The intersection of the new line with the curves for 4, 8, 16, or 32 nozzles allows determination of the nozzle pressure and flow rate. For example, the intersection of the new line with the curve for 16 size 1 nozzles (8 size 2 nozzles) indicates that the pressure would be less than 10 lb. per sq. in. at the nozzle (nozzle pressures are plotted along the curves). Since this pressure would give too low a rate of flow (see Figures 3 and 4), 8 size 1 nozzles would be used. The nozzle pressure for this system would be 38 lb. per sq. in. and the flow rate 10.5 lb. per sec.

The flow rate is greater than the minimum required for this system (8.3 lb. per sec.) and by reference to Figure 2 it is found to be greater than the minimum flow required to prevent surging and is therefore acceptable.

The discharge time for the system is obtained by dividing the capacity of the

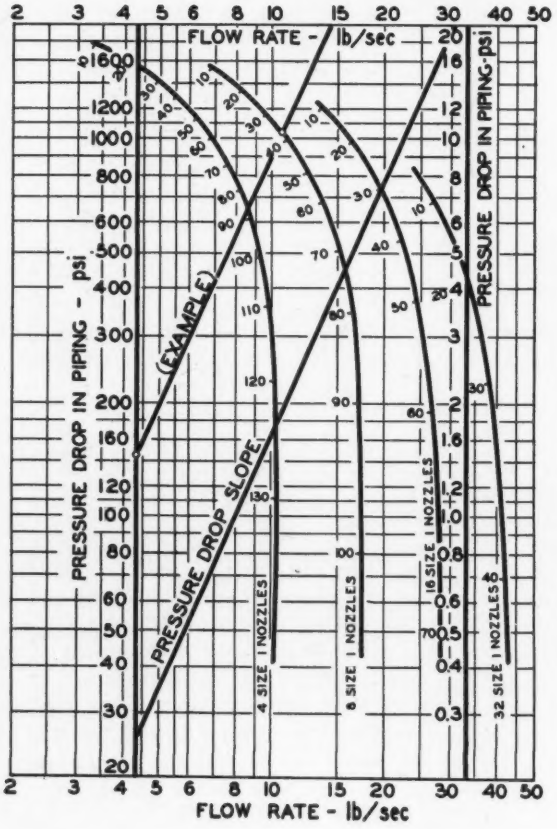


Figure 14. Calculations for the design layout of dry chemical systems involve many variables including outlet pressure, nozzle pressure, rate of flow, pipe size and nozzle size. These variables have been correlated in this graph to simplify the process of determining the values applicable to any particular system.

The example in the text shows how the graph may be used.

A detailed explanation of this graph will be found in a report published on October 25, 1954 by Underwriters' Laboratories, Inc. on the dry chemical extinguishing system of the Ansul Chemical Company.

dry chemical system unit, 150 lb., by the flow rate, 10.5 lb. per sec., and it is found that the result (14.3 sec.) is greater than the minimum discharge time (7.5 sec.) so the system as designed is acceptable.

A more detailed description of the calculations is given in the Underwriters' Laboratories report of October 25, 1954 on the dry chemical extinguishing system of the Ansul Chemical Company.

The development of a dry chemical extinguishing system has been described in this paper. The Underwriters' Laboratories now lists this system and it is expected that the Factory Mutual Laboratories will grant their approval in the relatively near future. However, further development is being carried out to allow the widening of limitations and to study new applications.

We wish to acknowledge the many valuable suggestions from J. A. Bono of the Underwriters' Laboratories, P. E. Johnson and W. S. Marsh of the Factory Mutual Engineering Division, and Mr. William Fairbairn (now retired) of the Factory Insurance Association.

Sloatsburg Dye Works Fire

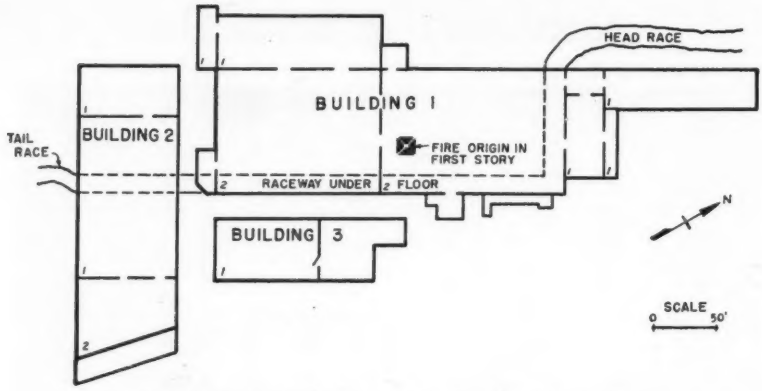
Suburban News

The principal source of income for the people of Sloatsburg, N. Y. was destroyed when fire leveled this textile mill. The plant was sprinklered but sprinklers were no match for the flash fire conditions prevalent in the lint-covered and undivided interior.

The one large industrial plant in the town of Sloatsburg, New York, was destroyed by fire March 19, 1955. An article published in the March 23 issue of the *New York Herald Tribune* and reprinted in the April NFPA *Quarterly** cited a few of the indirect effects of this fire on the people of Sloatsburg. It is now possible to describe in some detail the various factors responsible for the origin and spread of this $1,800,000 fire.

Two of a group of three industrial buildings that had been built during World War I for cotton cloth dyeing and finishing were destroyed by the fire. Textile processors had occupied the buildings since their construction and at the time of the fire the Ramapo Piece Dye Works and the Harry Schwartz Yarn Co., Inc. were the two occupants.

*". . . It'll Be Tough" in Sloatsburg for Awhile, published in the April 1955 *Quarterly*, pages 386-387.



Sloatsburg, New York, Dye Works Fire, March 19, 1955.

Construction and Occupancy

Except for a few small 1-story wooden additions and loading platforms the buildings were constructed of brick walls, heavy timber beams and columns, and wood flooring and roof decking. Two-story Building 1, where the fire originated, had a ground floor area of 40,000 sq. ft. including a 3,700 sq. ft. 1-story addition at the north end (see diagram). Building 2 was one and two stories high and 29,500 sq. ft. in area, and Building 3 was a 3,700 sq. ft. 1-story structure.

Because of unprotected vertical and horizontal openings each building constituted a single fire area and because of the nearness of the buildings to each other and the lack of exposure protection a serious fire in any one building would endanger the others.

The Ramapo Piece Dye Works occupied the north half of the first story of Building 1 for cotton and rayon cloth processing and the north half of Building 3 and most of Building 2 for storage of raw and finished stock. Both stories of the south half of Building 1 were occupied by the Harry Schwartz Yarn Co., Inc. as a full process worsted yarn mill. This company stored machinery, yarn waste, wood and other combustible material in the north half of the second story of Building 1.

Both stories of Building 1 were congested and dirty, machinery was covered with oil and lint, floors were oil-soaked and in the north half of the building there was a heavy coating of cotton and rayon lint on the ceilings. Housekeeping conditions had been criticized by the fire chief on several occasions and in 1954 his attempt to have cleanliness enforced through legal action was dismissed by the court.

Fire Protection

All buildings were protected by wet pipe sprinkler systems installed in 1918 when the buildings were constructed. An 8-inch village main fed by a reservoir three miles away was the primary water supply for sprinklers and yard hydrants. The inadequacy of this supply can be appreciated from pressure readings which dropped from a static pressure of about

100 pounds per square inch to six pounds per square inch at the top line of sprinklers with 330 gallons per minute flowing from a hydrant. A manually operated 1000 gpm steam fire pump that drafted from the mill raceway constituted the second source of supply. There were no connections through which fire department pumpers drafting from the raceway could pump into the sprinkler systems.

Other private fire protection consisted of five yard hydrants (there were also two public hydrants nearby), and central-station-supervised watchman protection during nights, Sundays and holidays.

Public fire protection consisting of one 750 gallon and one 500 gallon pumper manned by volunteer firemen could be supplemented by activating a county mutual aid plan.

The Fire

At the time of the fire the Ramapo Piece Dye Works was working 24 hours per day, seven days a week washing, sizing, tentering and drying cotton cloth for the summer dress season. Among the equipment used in the north half of the first floor of Building 1 were two open type gas-heated tenter frames on which cloth was dried after being washed and sized in water solutions.

At 10:20 P.M. a fire occurred in one of the open tenter frames because cloth had come loose from the frame and come in contact with the gas flame. This occurrence was apparently quite common due to the quality of the cloth, and as on past occasions, employees grabbed carbon dioxide extinguishers expecting to put out the blaze with a minimum of damage and work interruption. In this instance, however, the fire jumped to the heavy accumulation of lint on the ceiling before the extinguishers could be discharged and flames flashed across the lint and entered one of two unsprinklered combustible and flimsily constructed 3 ft. by 3 ft. ventilating ducts that extended vertically from the first story through the roof. The employees continued their first-aid fire fighting only briefly before recognizing the need for assistance. As one man ran to tell the night engineer to start the fire pump, another telephoned the alarm. The town siren blew at 10:40 P.M., just after one of the townspeople noticed flames belching from the roof opening of the lint-coated duct.

The watchman's actions during this period are an indication of the speed with which the fire developed. One minute before the town siren blew he had found everything in order as he pulled a central-station-supervised watchman's box in the north half of the second story of Building 1 (directly above the point of origin).

The first engine company arrived without undue delay and firemen reported hearing the sprinkler water-flow alarm ringing as they set up their pumper at the head race and took two hose lines into the north end of Building 1. Inside fire fighting could be continued for only a minute or so because of the intense smoke and heat, and since flames were then visible in the north half of the second story the firemen took up positions on a railroad embankment adjacent to Building 1 and directed streams through second-story windows. After connecting to a public hydrant the second engine company took a hose to the roof of Building 1, expecting to discharge it through a skylight, but dense smoke that billowed from the skylight when it was opened forced them to abandon this plan.

It was by then apparent that the fire was spreading rapidly through the first and second stories of Building 1 and help was requested under the county mutual aid plan. Eventually 300 firemen and 16 pieces of apparatus including eight pumpers responded but before this manpower and equipment could be mobilized the fast-spreading fire had jumped the narrow alley between Buildings 1 and 3 and had entered Building 3.

The first mutual aid company to arrive (10:58 P.M.) connected its pumper to a yard hydrant but got no water so relocated and took suction from the head race. As other pumpers arrived they also drafted either from the head or tail races. By concentrating hose streams at the north and south ends of Building 1 firemen were able to save the 1-story addition on the north end of Building 1 and kept fire from entering Building 2.

Al Rhoades

Lack of cleanliness was the primary reason for destruction of this Sloatsburg, N. Y. textile mill.

Sprinkler Performance

Since the buildings involved in this fire were equipped with two-source sprinkler systems one may naturally inquire why two of the buildings were destroyed. Investigators believe the answer lies primarily in the poor housekeeping conditions prevalent in this plant, and secondarily in the poor water supplies for sprinklers.

Reports of employees who saw the fire start indicated that it spread with great speed along the lint-coated ceiling and entered the unsprinklered combustible duct before sprinklers in the first story had time to open. Sprinklers later fused but by then the fire was raging in the lint-coated duct and soon burned through the duct wall and entered the second story where flash fire conditions were also present. Here again, many sprinklers opened simultaneously but it is doubtful if any water discharged because the poor primary supply must have been already overtaxed by the sprinklers operating in the first story. Whether or not prompt operation of the secondary water supply (manually operated 1000 gpm steam pump) would have materially remedied the situation is open to conjecture but in any case the secondary supply was nonexistent because the night engineer was not familiar with the proper procedure for operating the fire pump. Later, when electric power to the plant was shut off to protect fire fighters, the pump's steam supply was lost (steam was generated by an oil-fired boiler) but by then two of the three buildings were in flames and all pumpers were drafting from mill races.

Despite the poor water supply, the lack of cleanliness must be classified as a much more serious fire protection weakness in this particular plant, and under the conditions that existed it is doubtful if even a well-supplied modern sprinkler system could have controlled a large-area flash fire in these buildings.

Alcohol Plant Fire, Philadelphia

On May 26, 1955 the ethyl alcohol denaturing building at the Philadelphia, Pa., distillery of Publicker Industries, Inc. was destroyed by explosions and fire. Four men were killed and loss was estimated at more than $700,000. Evidence indicates that the explosions involved flammable liquid vapors which had reached dangerous concentrations in the building because certain fire protection practices that should have been followed to prevent flammable vapors accumulation were not permitted by the local branch of the Alcohol Tax Unit of the Bureau of Internal Revenue.

The Denaturing Building

The distillery site was 60 acres of congested buildings and tanks, occupied prior to 1926 by a fertilizer works and a cocoanut oil plant. The denaturing building in which the explosions occurred was 4,675 sq. ft. in area and four and five stories high. Walls were brick, beam supports and columns were exposed steel, and floors in the first, fourth and fifth stories were wood plank. At the second and third story levels floors were partially grilled. All stories were interconnected by unprotected vertical openings.

The bulk of the denaturants was stored in outdoor tanks but several sealed drums were kept in the fifth story where denaturants (e.g. methyl isobutyl ketone, kerosene, ethyl acetate, benzol, diethyl phthalate) were weighed in open tanks by government agents as needed and then poured down open troughs to denaturing tanks in the fourth story. The first through the fourth stories were congested with about 50 storage tanks from 250 gallons up to 25,775 gallons in capacity, there being an estimated 190,000 gallons of denatured and pure alcohol in the building when the first explosion occurred. Part of the first story was used for drum filling.

The denaturing building was protected by a dry pipe sprinkler system. With one exception details of the system are not important since rupture of piping by the first explosion nullified sprinkler protection. The one important feature of the system as it affected this fire was the location of the control valve in the basement. Water discharged from broken sprinkler piping for several hours because the valve was under debris and could not be shut off.

The Flammable Vapor Hazard

Because of practices followed in handling and storing flammable liquids in the denaturing building it was inevitable that flammable vapors would be present and in fact it is remarkable that the combination of circumstances necessary for an explosion had not been present in the past.

The denaturant handling method, which involved open weighing tanks and transfer troughs, was a prolific source of vapors. The flammable vapor hazard associated with this method had been recognized by company officials who desired to use closed containers and piping, but the local representatives of the Alcohol Tax Unit (responsible for adding denaturants) would not sanction these changes.

All piping and storage tanks were grounded and all tanks had vents equipped with flame arresters. However,

This is a preliminary report based upon the best information available as of the date of publication. However, it has not been possible to verify all details.—Ed.

United Press

Violation of several fundamental procedures for the safe handling and storage of flammable liquids was responsible for explosion and fire at this Philadelphia alcohol distillery. Four men were killed.

the vents discharged into the building. Here again efforts of the company to follow the recognized safe practice of terminating vent pipes outside the building were denied by government agents.*

Positive ventilation to prevent the accumulation of flammable vapors in hazardous concentrations is a fundamental of fire protection for any building in which flammable liquids are handled. Requests by the company for permission to install positive ventilation in the denaturing building had been turned down by government officials, and consequently windows were relied upon for ventilation (there were no windows in the first story). The company was also allowed to set up two fans to circulate air within the building.

*There is apparently no uniform policy among members of the Alcohol Tax Unit on ventilating requirements since ventilation to outside the building is permitted in Kentucky.

The Explosions and Fire

At 4:30 P.M. May 25, just before the alcohol denaturing building was locked up for the night, routine tests by a flammable vapor indicator showed that dangerous concentrations of flammable vapors were present. When the building was opened at 8:00 A.M. May 26, tests again indicated dangerous concentrations of vapors but the warning was not heeded since 24 company employees and five government agents were in the building at

8:18 A.M. when an explosion occurred that killed three employees and one government agent, blew out windows and frames and ruptured sprinkler and flammable liquid piping. The explosion appeared to be centered in the fifth story, but since the only person in the fifth story at the time was the fatally injured government agent, it was not possible to obtain eyewitness accounts of conditions in the top story just before the explosion.

On hearing the explosion employees in neighboring buildings immediately started to shut down boilers, stills and other process equipment, a procedure that may well have prevented a more widespread disaster. These men deserve credit for staying at their posts throughout the fire.

Fire broke out at once in the denaturing building and spread rapidly as alcohol from broken piping spilled down through the building. Firemen responding to the central-station-supervised sprinkler waterflow alarm immediately called for additional men and equipment and by 8:30 A.M. had sent in a fourth alarm. Because of the danger of explosions firemen surrounded the fire with 35 master streams and manned hose lines from relatively safe distances on roofs of buildings.

This precaution paid off. Shortly after 9 A.M. a second explosion occurred, of much greater violence than the first. This explosion has been attributed to violent rupture of a full 25,775-gallon tank, which evidently did not have adequate vent capacity, on an upper floor of the building. Structural members and debris were hurled in all directions and two buildings would in all probability have been seriously damaged by fires had not firemen been on the roofs of these buildings when they were struck by hot debris.

An extremely hot piece of metal tank support landed on the roof of a 1-story building 150 ft. from the denaturing building but was pushed to the ground by firemen before igniting the roof. A bonded warehouse adjoining the denaturing building was ignited by a piece of hot metal at a point 200 ft. from the denaturing building. Firemen on the roof extinguished the blaze before it burned through into the building.

Following the second explosion an additional alarm was sounded bringing the total equipment at the fire to 54 pieces of land apparatus and three fire boats. In all, ten 3½-inch, 42 2½-inch and five 1½-inch hoses were used to fight the fire and to wet down exposed buildings and storage tanks. Several pumpers drafted directly from the Delaware River which bounded one side of the distillery property.

Yard mains and sprinkler systems were normally supplied by two elevated storage tanks of 140,000 gallons total capacity. Water supplies were augmented by a fire boat that pumped into the yard mains through fire boat connections on a pier. Despite the steady drain on the yard system because of the broken sprinkler piping, pressure in the yard mains was maintained between 60 psi and 70 psi by continuous operation of one 750 gpm and a 1000 gpm fire pump.

The fire was under control by 11:00 A.M., although a wall collapsed 20 minutes later and a third explosion occurred at noon. Intermittent explosions continued through the 27th but by the morning of the 28th the explosions had ceased and firemen were able to search for victims. The Philadelphia Fire Department has been commended for its work in confining this fire to the building of origin.

Practical Gas Vent Design

By Richard L. Stone

Metalbestos Division, William Wallace Company

Until very recently, the entire gas industry has repeatedly tried to solve the problems of venting gas appliances, such as furnaces, water heaters, and room heaters, in terms of Btu vent capacity. I'd like to examine this concept of vent capacity to see what it means and to figure out whether we can really use it. Suppose we start out with an analogy. Let's ask a carpenter what the capacity of a 2x4 or 2x10 is. He won't even know how to begin to answer. Obviously from the standpoint of design, the capacity of a structural member depends on the span, the spacing, type of wood, the position of the member, the type of end support and many other factors. Although the carpenter doesn't know the capacity of the 2x4, this apparent ignorance doesn't keep him from building houses of adequate strength. He follows simple time tested rules of *application* or *design,* which tell him what to do, and thus he obtains a usable floor or wall or house.

Vent Capacity

Now let's start thinking in terms of vent capacity. Here we have the 2x4 situation all over again. Since I'm supposed to be an expert on vent capacity, let's assume a vent installer asks, "I have a gas vent 20 feet high and 6 inches inside diameter. What is its capacity?" I couldn't give a straight answer. I'd have to ask him all kinds of things, such as: What kind of appliance? What are the draft hood operating characteristics? Do you care whether there is any condensation? Will there be a vent connector or lateral? How many elbows? Do you intend to connect one or two appliances? Is it Type A, Type B, or Type C vent?, and lots more. Faced by this barrage, after asking a simple (?) question, the installer thinks to himself, "This guy might be an expert, but he sure is no help to me," so he goes back and finishes the installation the way he always did.

What's wrong here? How can we really provide some useful information? I think the answer is fairly simple but it has taken a long time to see it. There can be no readily useful answer to the vent capacity question, because it is the wrong question for the installer to ask. The installer doesn't really care what the capacity of a vent is. His question is: Here's an appliance, and here is a house—how should the vent be installed (or designed)? To the architect, builder or installer, capacity is a theoretical question. The practical problem is simply how to install a gas vent that works, and won't cause service calls, or spillage at the draft hood, or internal condensation, or excessive temperatures on adjacent combustible construction. So far as the average contractor or installer is concerned, we have to have a practical guide to vent design, so that he can decide quickly how the vent must be installed and be sure it will work.

For the engineer who is working on theoretical problems of gas venting, or on the computation of design tables, vent capacity is a useful concept. In its broadest sense, vent capacity refers to the usable calculated operating span of flow in a gas vent, within temperature, condensation and spillage limits. Capacity thus is not a simple number and depends on factors such as the kind of appliance attached to the vent as well as on the vent material itself. I think that we ought to start thinking in terms of the vent design problem, so that we can eventually furnish consistent standardized design data for all types of vent material.

Condensed from a talk presented at the 59th NFPA Annual Meeting held in Cincinnati, Ohio, May 16-20, 1955.

Vent Design Tables

The vent design tables recently developed and published by my company represent a practical approach to obtaining gas vents which work. They were developed using the Kinkead equations of vent operation as a means of combining, coordinating and correlating known and tested gas appliance operating characteristics, with other factors established by 10 major American Gas Association research projects. The Kinkead equations provided a unified overall plan to show how we could make the important transition from vent capacity to vent design. Until the development of these equations, the various contributions of the AGA requirements testing program, and of the many AGA research projects (costing hundreds of thousands of dollars) remained isolated facts, with no apparent place in any overall plan. Now that we are able to take a more purposeful and enlightened point of view, I think it is important to see what we can do to solve the problems which still face us.

Before discussing the significance of the Kinkead equations, I'd like to backtrack a bit and analyze the tremendous contribution that various Association activities have made to the development of the vent design tables. To a considerable degree our vent design tables were made possible by the scope and effectiveness of the American Gas Association's approval requirements and research programs, as well as by the standardization and code activities of organizations such as the NFPA, Underwriters' Laboratories, the Pacific Coast Building Officials Conference and the Southern Building Code Congress.

Approval Requirements

First, let's look at the American Gas Association's Approval Requirements testing program and how it has helped us develop the tables. This program establishes appliance operating characteristics by test and thus sets the flue gas compositions and temperatures with which the vents must deal. A gas vent doesn't operate by itself. The flue products from the appliance must supply the motive force (as heat) to provide for their own disposal. By extensive testing the Approval Requirements program firmly establishes the limits and values of many gas appliance operating characteristics, such as quantity and heat content of the vent gases, as well as draft hood operating characteristics and minimum vent height.

A knowledge of the values and limits of these factors was essential to the development of the vent design tables.

The research program of the American Gas Association has also made a major contribution to the development of the tables, by providing a great many useful items of information. Useful data was furnished on combustion air supply, on heat transfer in gas furnaces, on draft hoods, on venting both in the laboratory and in the field, and on the functioning of warm air heating plants in full size houses.

Other organizations have also furnished useful factors and research data which contributed to our development of the tables. The Southern California Gas Company some years ago did considerable research on the tests for a pressure-neutralizing vent top, cowl or termination. Tops tested and approved for compliance with the City of Los Angeles Code, based on this research may be assumed to perform better under a wider variety of conditions than those not tested under any standard.

The contribution of Underwriters' Laboratories in developing, upgrading and enforcing standards of performance for gas appliance flues, is of primary importance. They deserve credit for recognizing the need and great potential usefulness of lightweight prefabricated piping developed specifically for venting of gas appliances, as well as for developing vent piping test standards which will insure a minimum heat transfer coefficient or U value.

Several attempts have been made in the past to organize the various factors of the vent design problem into a coherent, unified approach. Until the advent of the Kinkead equations, however, these have all had serious shortcomings. The first and most important contribution to this specialized art of vent design was made by Frank Wills. He tried to solve the venting problem in terms of constant draft hood dilution and maximum vent capacity. Also he had no exact way to handle heat loss and was unable to show how heat loss can reduce vent gas flow. A subsequent approach in terms of design was made under an AGA research project, which culminated in some complicated looking grid charts. This approach also fell short of the mark because it neglected the variable heat loss factor, as well as being rather difficult to use.

Kinkead Equations

What are the Kinkead equations, and what do they mean? They were developed by Alan Kinkead, of our company, and were first published in 1952.* They resulted from the first complete analysis of the functioning of a gas vent. Fundamentally they represent a new application of some very old and familiar laws, although it takes a mathematician to track them down. These laws are simply the law of gravitation, the law of conservation of energy, and the second law of thermodynamics. Although these natural laws can't be proved, I don't know of any instances where they have been disproved either. For the exact statement of the law of gravitation, we have to give credit to Sir Isaac Newton. In a gas vent, Newton's law of gravitation simply states that gases which are lighter than air tend to rise because of the difference in gravitational force. The law of conservation of energy for flowing fluids is generally called Bernoulli's theorem. For gas vents this law establishes how potential energy in the density difference between hot gas and surrounding air, is converted into flow and various energy losses. The second law of thermodynamics, which states simply that heat flows from hotter to colder levels, is applied here as Fourier's law of heat flow.

In mathematical form the Kinkead Equations may be written as follows:

$$\beta = 2000 \frac{P}{30} \frac{A}{T_2} \left(\frac{H}{R}\right)^{\frac{1}{2}} \frac{(t_a)^{1.5}}{T_1}$$

$$\frac{B}{\beta} = \frac{t_o}{t_a} = e^{\frac{0.263\ UD\ (x_a)(t_a)}{\beta}}$$

β	Heat in vent gases flowing past mid-point of vertical section, Btu per hr.
P	Barometric Pressure, inches of mercury
A	Area of vent piping cross section, square inches
T_2	Vent gas temperature, deg F absolute
H	Height of vent piping from draft hood to top, feet
R	Frictional resistance of vent system, velocity heads (includes draft hood, piping, fittings and end loss)
t_a	Gas temperature rise, deg F above ambient, at mid-point of vertical section of vent
T_1	Ambient temperature, deg F absolute
B	Heat in vent gases at draft hood, Btu per hr
t_o	Gas temperature rise, deg F above ambient, at inlet to vent system (or draft hood outlet)
e	Base of Napierian logarithm, 2.718
U	Overall heat transfer coefficient of vent piping, referred to inside area of vent piping, between vent gases and ambient air; Btu per (Hr) (sq ft) (Deg F)
D	Inside diameter of vent piping, inches
x_a	Distance along center line of vent piping, between draft hood and mid-point of vertical section, feet

A typical problem of vent design might be stated as follows:

*Operating Characteristics of a Gas Vent by Alan Kinkead. Published in Pacific Coast Gas Association Proceedings, Volume 43, 1952.

Given a typical gas appliance at sea level, rated at 80,000 Btu per hour heat input having a sensible heat loss of 12% (B=9,600 Btu per hour) with four inch vent collar, is to be vented into four inch vent piping having a U value of 0.60. The vent will run 15 feet laterally, 20 feet vertically, and have two elbows. Find the vent gas temperature and heat quantity at the mid-point of the vertical section of the vent, and at the inlet to the vent. The mid-point of the vertical section will be halfway up the vertical, or a distance of (15+10) feet from the draft hood. This establishes x_a as 25 feet. Corresponding values of β and t_a exist at this point.

Inspection of the equations will indicate that they have two unknowns, since "t_a" determines the gas flow, which determines heat loss as well as β. They can be solved by successive approximations. The other quantities may be estimated from the information given.

For purposes of a solution, in addition to the data given, we can estimate P=30, T_1=520°F, A=12.6, H=20, R=6.5, and D=4.

Answers are: t_a=170°F, β=6200 Btu per hr. and t_o=264°F above room temperature. The value of B was given as 9600 Btu per hour.

The equations can be applied in this manner to individual vents of any configuration or type of piping, and can be used to calculate outlet temperatures, also the possibility of draft hood spillage. They can also be extended to design of combined and multiple vents.

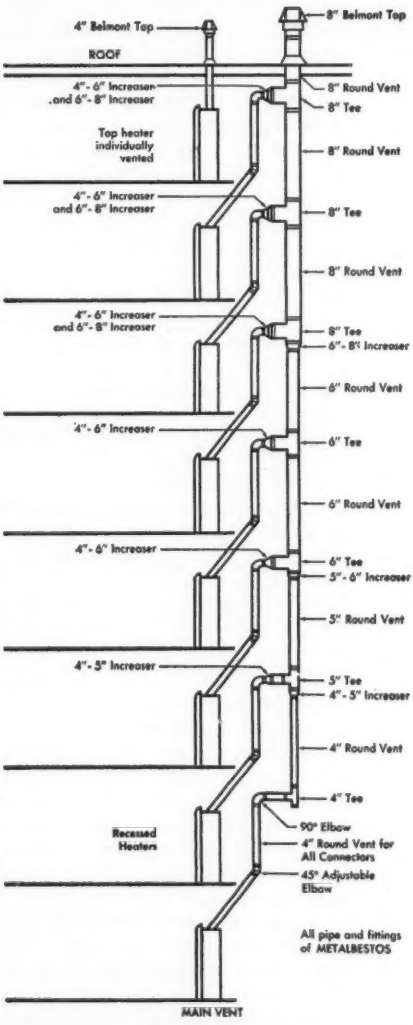
For practical purposes, we can define a valid theory as a method of interrelating pertinent factors of a problem which can predict what will happen. Einstein's theory of relativity applies equally to predicting electron orbits and to motion of light in space. Perhaps the most impressive proof was the verification that light from a distant star, passing through the gravitational field of the sun, would be deflected in a direction and amount exactly predicted by the theory. It took only one experiment to prove this, and thus establish the validity of Einstein's entire theory. In the same way, it takes only one experiment to prove that the Kinkead equations will predict the operation of a gas vent. All that needs to be done is to set up any arrangement of vent piping with known resistance factors, and heat loss, and to compute the flows and temperatures. We have done this in our own laboratory hundreds of times. Stanford Research Institute has also made a thorough investigation of the same equations, which work every time. From these tests, we know that the Kinkead theory works and can be used with confidence to predict the operation of any gas vent.

Gas Vent Design

Translation of the Kinkead equations into practical gas vent design, requires practical experience, as well as background data on operating characteristics of gas appliances, draft hoods, gas vent design, and conventional installation practices. This data has been provided by analysis of AGA approval requirements and by selection of pertinent data from applicable research projects, as I have previously shown.

In addition, as manufacturers of Type B insulated double wall gas vents, with 18 years of experience in making and improving this product, we have contributed a great deal of our own practical experience to the design tables. We have made enough gas vent pipe to bring the total number of insulated Type B vent installations to well over a million. Furthermore, the use of double wall Type B vent is growing all the time. As new homes are built, as gas heat is supplied to older homes and as low cost natural gas for heating is brought into new areas of the country, the total number of Type B gas vents increases steadily.

Type B insulated gas vent, in addition to its effectiveness in gas venting, is solving many problems for the building industry. Multi-story Type B gas vents, as shown in Fig. 1, first proved by the



SCHEMATIC ELEVATION OF MULTI-STORY VENTING INSTALLATION FOR RECESSED WALL HEATERS BERNAL APARTMENTS, SAN FRANCISCO

DETAIL OF INDIVIDUAL VENT CONNECTORS (SAME ON ALL FLOORS)

DESIGN FOR MULTI-STORY VENTING
By Metalbestos Division, William Wallace Company

Fig. 1

Bernal Housing Project in San Francisco, are being designed for other areas of the country. For large size appliances, the upside-down manifold, shown in Fig. 2, has been used, where the largest available vent diameter is not great enough.

Results of Tests

A large segment of the gas appliance industry owes a measure of its recent acceptance and success to the vent industry. Here, I refer to the vented, recessed wall heater, for which the development of the Type BW vents, by the vent industry, permitted simple inexpensive appliance installation in walls. The results of tests recently completed in Los Angeles have again confirmed that a Type BW vent installation is a satisfactory, safe method of venting recessed wall heaters.

Having shown that the testing and research activities of the gas industry can be translated into practical vent design methods, the question arises, what can we do with the vent design tables, as derived from the Kinkead equations, and applied to our venting problems? Are they really practical and can they lead to improved standards for gas venting? Fundamentally, the tables provide an instruction manual for contractors, installers, architects, and engineers for design of individual, combined, and manifolded vents. They cover the more common sizes at present and can be readily expanded to include larger sizes, and other vent size combinations.

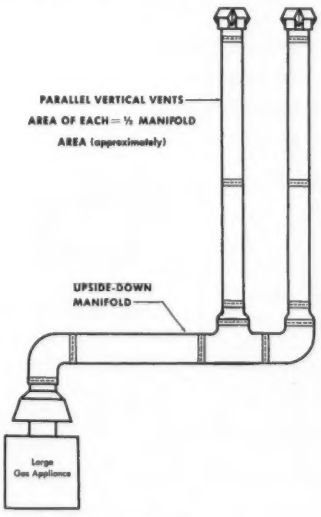


Fig. 2

Safety Factors

For the safety and benefit of the installer, of the user, and of the entire gas and construction industry, the tables show how to design insulated Type B gas vents using three important factors of safety. These factors are introduced into the practical design simply and automatically and by following recommendations in the tables. Thus the installer doesn't have to concern himself with any calculations or unusual precautions.

These safety factors are:

(1) Prevention of spillage of flue gases from the appliance draft hood, by designing the vent for adequate flow of vent gases.

(2) Prevention of condensation of moisture from flue products within the vent, by limits applied to heat loss from double wall insulated vent piping.

(3) Prevention of excessive temperature on adjacent combustible material by limiting design vent gas temperature rise to not over 300 degrees F, above room temperature.

The Kinkead equations, for the first time, made it possible to incorporate all three of these important factors into design tables. Previously available methods offered no assurance that spillage, condensation, or excessive temperatures could be avoided.

For combined vents, where two appliances are connected to a common vent, a further development of the Kinkead equations was applied. Our analysis and tests showed the most critical design condition of a combined vent existed when one appliance, usually the smaller appliance, operated by itself. In our company laboratory, the operation of a combined vent system was analyzed by a set of care-

fully controlled laboratory experiments. Our procedure for analysis of a combined vent showed that as connector rise is increased, the required height of common vent is reduced. Once you start to think about it, it is fairly obvious that as the rise in the connector increases it becomes increasingly self-venting and the need for the common vent eventually decreases to zero, as shown in Fig. 3. Using a foot of extra connector rise may permit reducing not only the required total height of vent, but its size as well, thus resulting in considerable economy. Furthermore, the tables show that where limited ceiling height reduces the obtainable connector rise, an appliance with a larger size connector will permit an economical combined vent installation.

If you wish to see how we have approached the problems of practical gas vent design, a copy of our tables can be obtained by writing to the William Wallace Company, Belmont, California.

Future Progress

The vent design tables point the way for the gas industry and the construction industry to make a fresh start toward better gas venting by thinking in terms of design methods and standards, rather than belaboring the concept of capacity. The opportunity is here for all organizations concerned with development and enforcement of building codes to study the tables from this point of view. We feel that with the theoretical tools available, all types of vent materials, and all traditional methods of installation, such as chimneys, can be studied from the design aspect and data can be developed on the best methods of application to gas vent design. A research program for this purpose has recently been organized. Now that we clearly understand the problem, and have seen the means of solving it, nothing should be allowed to interfere with progress toward an industry-wide standard for good gas vent design.

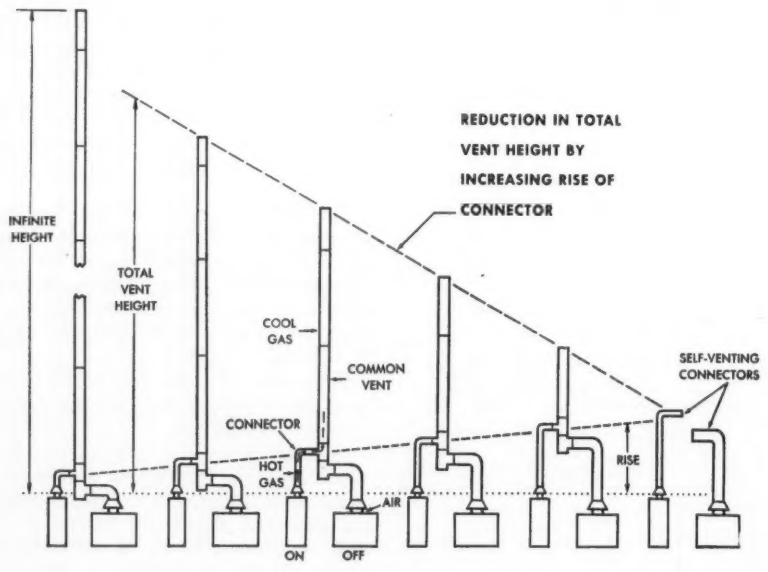
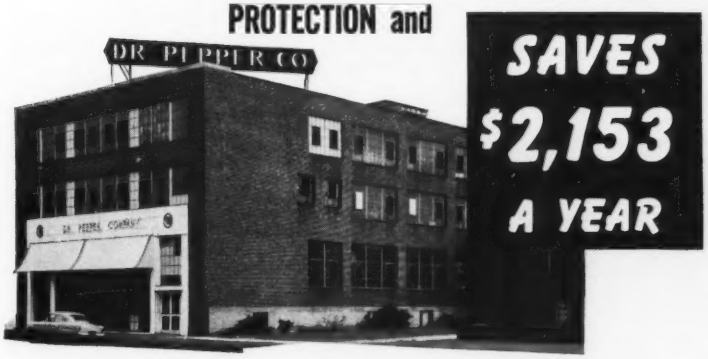


Fig. 3

DR. PEPPER COMPANY branch syrup plant, Birmingham, Ala., protected *Automatically* gets better FIRE and BURGLARY PROTECTION and



"The ADT automatic protection used in our Birmingham Syrup Plant has not only been a great benefit to us from an efficiency standpoint, but each year it has lowered our building protection costs $2153."

Vice President in Charge of Production E. A. Millican

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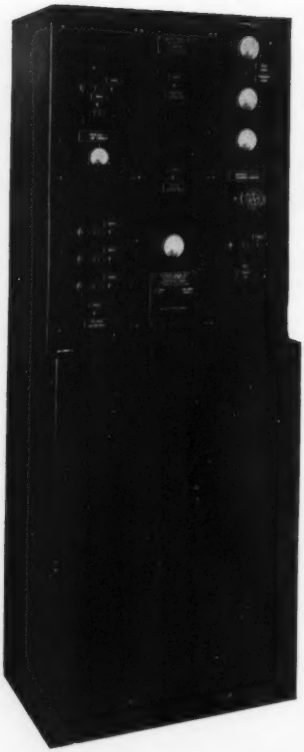

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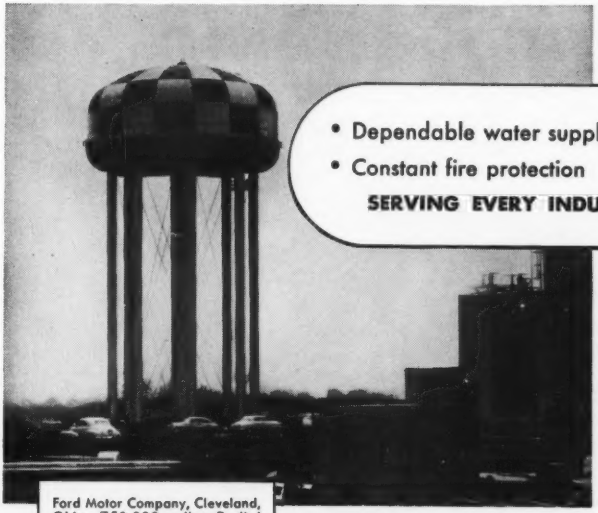

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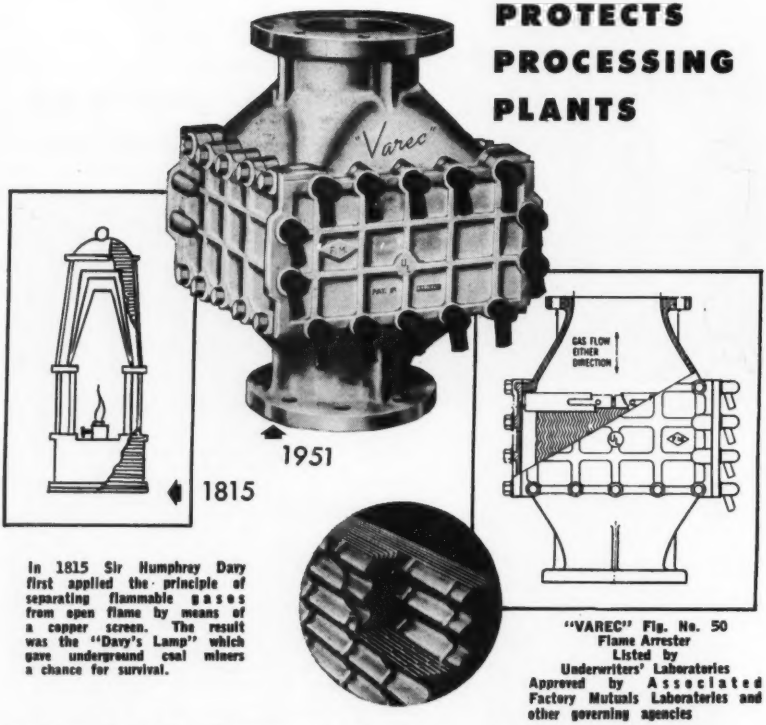

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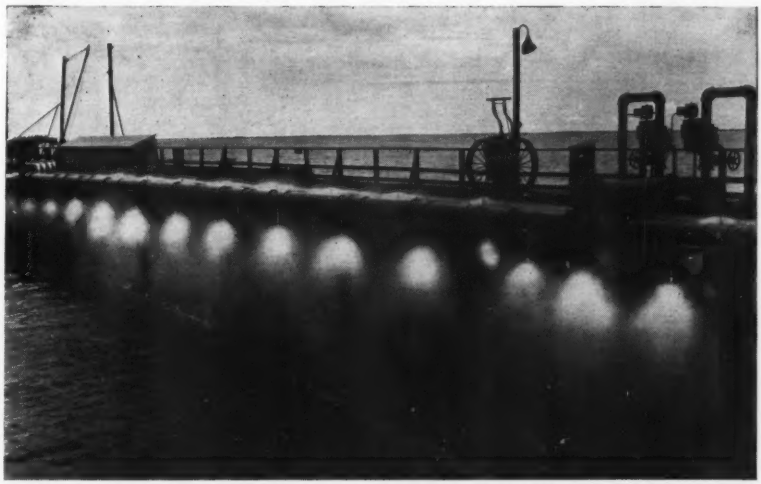

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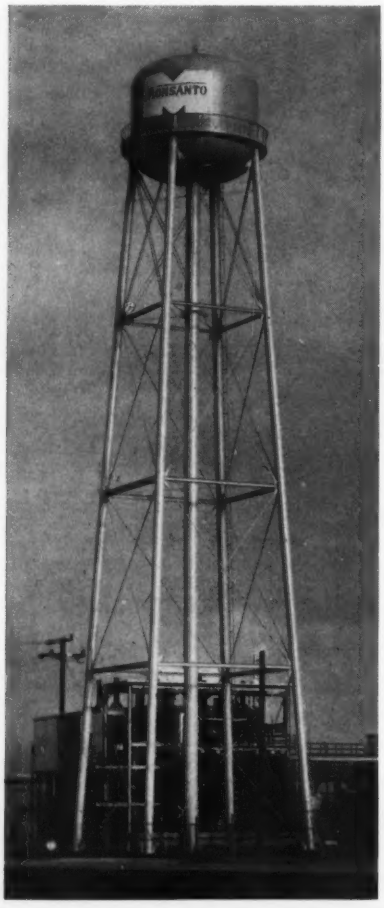

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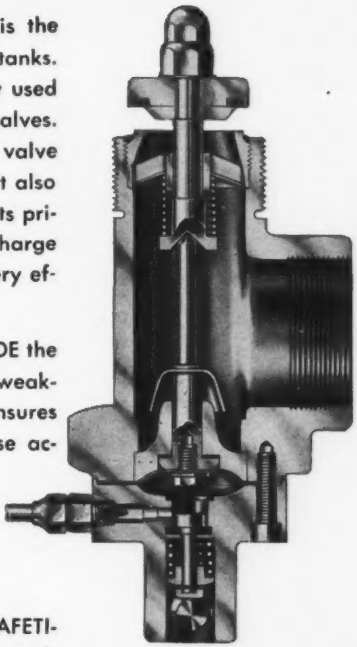

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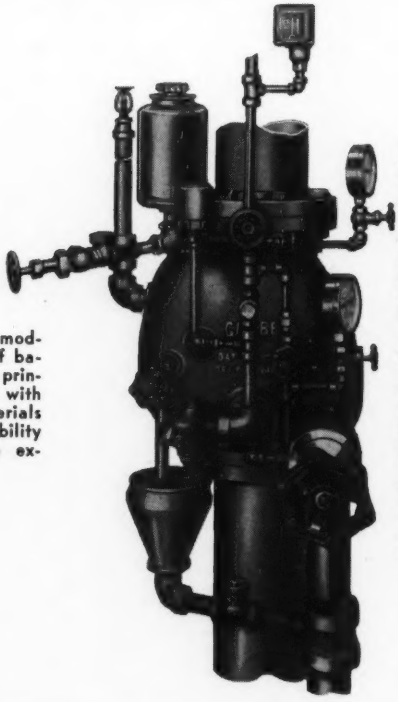

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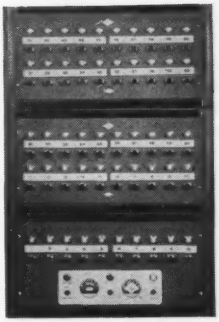

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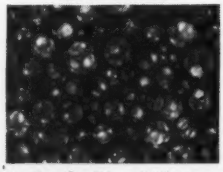

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The minute closely-knit bubbles retain the maximum water content in a foam that is both adhesive and cohesive. This is the reason that air foam made from Nicerol resists fire breakdown, puts out more fire faster, and definitely outlasts the fire to prevent flash-backs.

INQUIRIES INVITED FROM DISTRIBUTORS AS WELL AS USERS.
FULL TECHNICAL AND COMMERCIAL DETAILS AVAILABLE FROM

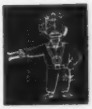
GEORGE T. REYNOLDS & ASSOCIATES, P.O. BOX 395, THORNWOOD, NEW YORK., U.S.A.
BRITISH FIRE EXTINGUISHERS LTD., 222 SIMCOE ST., TORONTO 2B, ONTARIO, CANADA

this was so unnecessary

A Blaw-Knox Automatic Sprinkler System could have prevented it

Most uncontrolled fires are so unnecessary. The damage done in property destroyed, plants lost, inventories wiped out, records ruined, and businesses shut down can never be recovered. Yet, a Blaw-Knox *Automatic* Sprinkler System can stop fires at their origin, keep damage down to a small area, and pay for itself in a few years by savings in reduced insurance premiums.

"Little Joey Sprinkler" always on the job.



BLAW-KNOX COMPANY
Automatic Sprinkler Department
829 Beaver Avenue, N.S., Pittsburgh 33, Pa.

DETECT-A-FIRE®

Rate Compensation Actuated THERMOSTATS insure positive Fire Detection for alarm or release systems

Fenwal DETECT-A-FIRE units are based on an entirely new principle. The outer shell is the sensing element — reacting to the temperature of the air around it. The contacts function when surrounding air reaches a danger level.

- *Hermetic Sealing* of internal electrical components.
- *Stainless Steel Construction* — for corrosion resistance and long life.
- *Temperature Setting Range*, 140 F to 725 F.
- *Long Spacing* . . . 25 feet . . . economy of installation.
- *Repeatable.* Unit re-sets itself, nothing to replace.
- *Shock and Vibration Resistant* . . . rugged construction.

SERIES 70 HORIZONTAL MODEL.

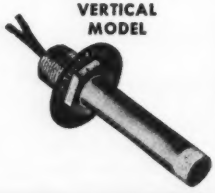
For locations where appearance is a factor. Suitable for all commercial, industrial, mercantile and public buildings, institutions and ships, in locations classified as "ordinary" under the National Electric Code.

TYPES 7020 and 7021

Flush Mounting Unit for new construction and concealed wiring. Type 7020, normally closed circuits; Type 7021, normally open circuits. Designed to fit standard 4" junction boxes. For exposed wiring, Types 7020-1 and 7021-1 with surface adapter ring.

LISTING and APPROVALS: Ⓤ, ⟨◈⟩, USCG, and American Bureau of Shipping Acceptance.

SERIES 71 VERTICAL MODEL



For ordinary and hazardous locations i.e., Class I, Groups C and D; Class II, Groups E, F, and G. Explosion-proof in itself. For hazardous locations, mount to Crouse Hinds CPS 021 Cover or Appleton BFGS Hub Cover for explosion-proof system.

TYPES 7120 and 7121

For concealed and exposed wiring. Type 7120, normally closed circuits. Type 7121, normally open circuits.

LISTING and APPROVALS: Ⓤ, ⟨◈⟩, and American Bureau of Shipping Acceptance.

SEND FOR THESE BULLETINS.

They give the latest authoritative data on fire or overheat detection. They discuss in full the rate compensation principle; give exact engineering data. Write for Bulletins MC-107A and MC-108 to Fenwal Incorporated, 147 Pleasant Street, Ashland, Mass.

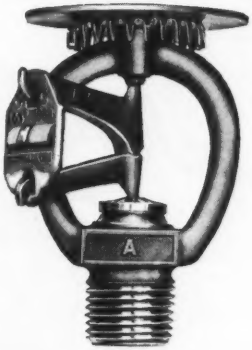
Fenwal

DETECT-A-FIRE® Thermostats

DYNAMIC, RATE COMPENSATION ACTUATED FIRE DETECTORS

Ahead Again!

CENTRAL SPRAY SPRINKLERS



Central Upright Spray Sprinkler Type "SSU"

BETTER FIRE PROTECTION

Combining all the superior features of the Central conventional type of automatic sprinklers (which 35 years of unequalled service have demonstrated) with the Central specially designed spray type of distributors, we present the complete line of Central Spray Sprinklers.

Central Spray Sprinklers are more effective and more efficient than any other type of sprinkler.

CHEAPER COST OF INSTALLATION

Their greater area of distribution and their lesser consumption of water combine to produce earlier extinguishment of fires with less water used, smaller pipe sizes and, in most cases, a lesser number of sprinklers required for the same areas.

Therefore, you save money in first installation cost and your fire damage is lessened if a fire occurs.

In every way, you profit by using the latest developed and the most efficient Central Spray Sprinklers.

Manufactured and Installed by

CENTRAL AUTOMATIC SPRINKLER COMPANY

Fourth Street and Cannon Avenue, Lansdale, Pa.

Cable Address — "Sprinklers" — Philadelphia

Licensees in principal cities in U. S. of America and Canada and throughout the world.

The AMAZING New

Star Spray Sprinkler!

(MODEL C—UPRIGHT)

With its

Unequalled Performance

Gives You . . . . . .

SUPERIOR PROTECTION — revolutionary in method — for any type of occupancy — no matter how severe the hazard . . . . . with **LESS WATER USED** — more effectively and more efficiently — for total extinguishment and cooling. . . . All water discharged goes directly on the fire — not on the ceiling. . . . Ceilings are so cooled that no sprinkler will open unnecessarily. . . . . **STAR SPRAY SPRINKLERS** — the ultimate in modern fire protection — can replace former-type sprinklers without changes in piping. . . . . Available for installation in either **UPRIGHT** or **PENDENT** position.

Approved by Factory Mutual Laboratories
Listed by Underwriters' Laboratories, Inc.

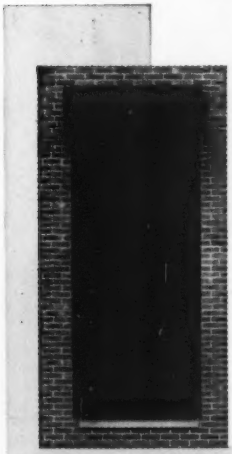
Write for name and address of STAR licensed contractor nearest your location, to:

STAR SPRINKLER CORP.

Westmoreland and Collins Sts. — Philadelphia 34, Pa.

Licensees in all Principal Cities of the United States and Canada

Automatic Rolling Steel
FIRE DOORS *and* WINDOW SHUTTERS
PREVENT SPREAD *of* FIRE!



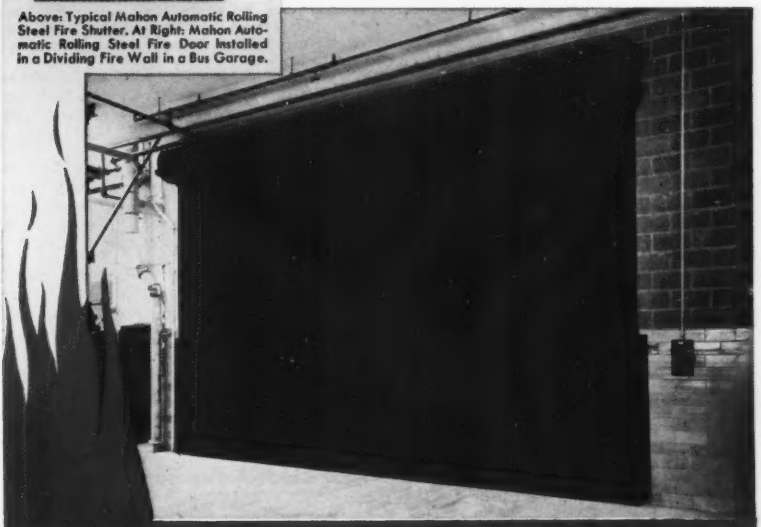
You need good automatic fire doors in fire walls, corridors, and vertical shafts . . . in some cases automatic rolling steel window shutters are necessary to protect your building and its contents from fires which may originate in nearby buildings. Many, many cases are on file which confirm that timely action of automatic rolling steel fire doors and window shutters have confined a fire to its point of origin and permitted its being extinguished with comparatively small damage. Make a survey of your building now, and don't delay action. You will find a Mahon Automatic Rolling Steel Fire Door or Window Shutter to meet each of your requirements—all bear the Underwriters' Label. These automatic fire doors may be operated manually or mechanically in every day use. If a fire should break out while they are in the open position, the automatic mechanism will close the door, cutting off drafts and preventing the spread of the fire. See Sweet's Files for complete information, or write for Catalog G-55.

THE R. C. MAHON COMPANY

Detroit 34, Michigan • Chicago 4, Illinois

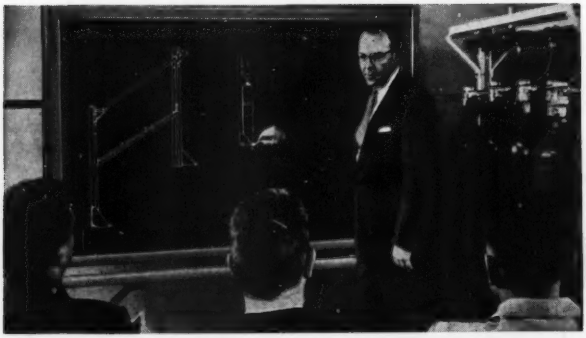
Manufacturers of Automatic Rolling Steel Fire Doors and Window Shutters. Also Many Types of Standard General Service Rolling Steel Doors and Grilles, Insulated Metal Walls, and Steel Deck for Roofs, Floors and Partitions.

Above: Typical Mahon Automatic Rolling Steel Fire Shutter. At Right: Mahon Automatic Rolling Steel Fire Door Installed in a Dividing Fire Wall in a Bus Garage.



MAHON ROLLING STEEL FIRE DOORS and WINDOW SHUTTERS

GREATEST FIRE-FIGHTING DESIGN ADVANCE IN 25 YEARS!



This Kidde Automatic Pressure-Operated CO_2 Extinguishing System is brand-new from the floor up!

✓ CHECK THESE 7 FEATURES!

☐ **1.** NO FALLING WEIGHTS: No clumsy mechanical triggering methods. Pneumatic or Electrical Control Heads automatically trigger CO_2 cylinders, assure complete discharge. All moving parts self-enclosed to prevent accidental operation!

☐ **2.** EASIER INSTALLATION! New racking arrangement is pre-drilled, eliminates need for special tools or materials. Can be either "free standing" or wall mount. Special racking also permits weighing of CO_2 cylinders *in place while connected*, giving uninterrupted protection even while weighing!

☐ **3.** SIMPLE TESTING! Disconnect control heads from cylinders, and *all* operating parts can be tested *in place!* All actuating parts have visual indicator which shows at a glance whether system is "set" or "released."

☐ **4.** NO PARTS TO REPLACE! Even after a fire, operating parts of the new Kidde system can be re-set with a screwdriver. No parts need be replaced. Refill cylinders and system is ready for operation.

☐ **5.** MULTIPLE PROTECTION! Automatically-operated Directional Valves let you protect more than one hazard from the same bank of cylinders!

☐ **6.** NO OUTSIDE POWER NEEDED! The new Kidde system is completely self-contained, has rate-of-temperature-rise detectors which give sure protection even in case of outside power failure!

☐ **7.** AUXILIARY EQUIPMENT! Also available for use with the new Kidde system are devices for turning power on or off, for opening or closing doors, windows, dampers, etc.

Fully approved by Underwriters' and Factory Mutual Laboratories.

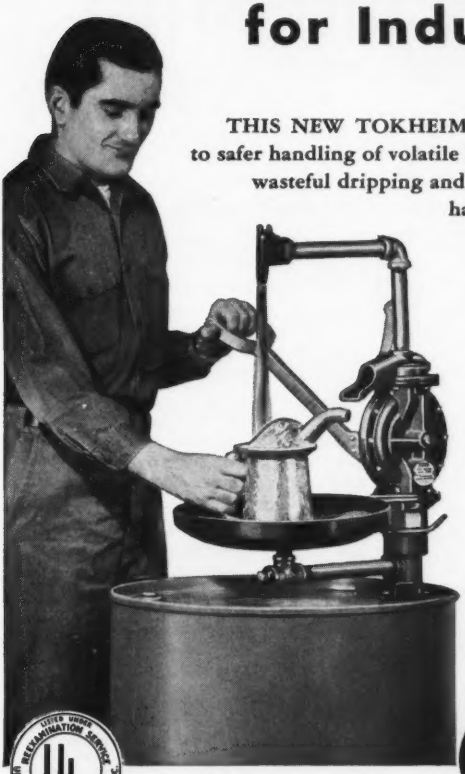
Complete details of this revolutionary new system are contained in Kidde's Pressure-Operated System Booklet. Write for your copy today!

Kidde (K Kidde) **Walter Kidde & Company, Inc.**
751 Main Street, Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd., Montreal—Toronto

The words 'Kidde', 'Lux', 'Lux-O-Matic', 'Fyre-Freez' and the Kidde seal are trademarks of Walter Kidde & Company, Inc.

SAFER

liquid handling for Industry



THIS NEW TOKHEIM HAND PUMP contributes to safer handling of volatile liquids wherever used. Stops wasteful dripping and slippery floors. Reduces fire hazard and accidents common to other methods of liquid transfer. Approved for handling petroleum liquids —ideal for many others. Available in 22 different models for 'most any use— from pipe lines to drums, or underground tanks, with hose or spout outlets. Order from your dealer, your oil company, or your Tokheim representative.

Write factory for literature.

QUALITY TOKHEIM HIGH VACUUM HAND PUMPS

General Products Division

TOKHEIM CORPORATION

DESIGNERS AND BUILDERS OF SUPERIOR EQUIPMENT

1686 Wabash Avenue *SINCE 1901* **Fort Wayne 1, Indiana**

Factory Branch: 1309 Howard St., San Francisco 3, California

Canadian Distributor: H. Reeder, 205 Yonge Street, Toronto

NOW. . . THE STANDARD IS SET!

a gas vent as finely engineered as today's most modern gas equipment

RV METALBESTOS

ROUND GAS VENT — *companion product to new* WV METALBESTOS *oval vent*

designed, tested and proved by the most extensive gas venting research program ever conducted.

HERE ARE THE REASONS WHY METALBESTOS IS THE SAFEST, MOST DEPENDABLE TYPE B GAS VENT

THE ROTA-LOCK COUPLER* an exclusive METALBESTOS feature

- a slight turn and it locks — permanently
- another easy turn and it unlocks (saves fitting time during installation)
- no tools or screws — no cement or mastic

LOCKED
TURN OF COUPLER BAND ENGAGES TONGUE IN GROOVE – PIPES SECURELY LOCKED TOGETHER
UNLOCKED
TONGUE RELEASED – PIPES EASILY COUPLED AND UNCOUPLED

* Patent Pending

EXTRA SAFETY fire-resistant steel outer pipe; permanently tight joints; improved double-wall, air-insulated design; you can be sure it's safe.

GREATER STRENGTH rugged steel outer jacket protects inner pipe, won't crack, break or collapse; sturdy, reinforced Rota-Lock Couplers.

LEADERSHIP IN GAS VENTING first to make a double-wall, insulated vent; first in gas venting research; and now a complete, vastly improved venting system — RV (round) and WV (oval) Metalbestos — to set the standard for scientifically correct venting.

RV Metalbestos is furnished in a complete line of pipe and fittings — 3" to 6" in diameter.

RV Metalbestos is listed by Underwriters' Laboratories as a Type B vent for venting approved gas appliances. Not for use with oil-burning appliances or gas-fired incinerators.)

Stocked by principal jobbers in major cities. Factory warehouses in Atlanta, Dallas, Philadelphia, Des Moines, Chicago, New Orleans.

METALBESTOS DIVISION
WILLIAM WALLACE COMPANY · BELMONT, CALIF.

It's you need to read this booklet NOW!

Records show 4 out of 5 industrial boilers are NOT protected against the explosion hazards of burning fuel.

WHEN A BURNER flame fails without instant cut-off of fuel, an explosive mixture collects . . . and may ignite disastrously on hot firebrick. A delay of only 30 seconds can spell tragedy, yet most "safeguards" in use today simply do not act that fast!

What can you do for proper protection . . .?

Send for this free booklet. With it you can check the protection any plant has, and determine the protection that is really needed.

PLAY SAFE! SEND TODAY!

fireye®

FIRST and FOREMOST IN INSTANT FLAME FAILURE PROTECTION

COMBUSTION CONTROL DIVISION
ELECTRONICS CORPORATION OF AMERICA
Dept. C26-7, 718 Beacon Street, Boston, Mass.

Please send me your FREE booklet, "Guarding Your Properties Against Flame-Failure Explosions".

Name .....

Firm .....

Address .....

ROLAGRIPS

for plain end pipe, 1½" to 12". No threading, grooving, flanging or welding.

fast, flexible, low cost sprinkler system couplings

GRUVAGRIPS

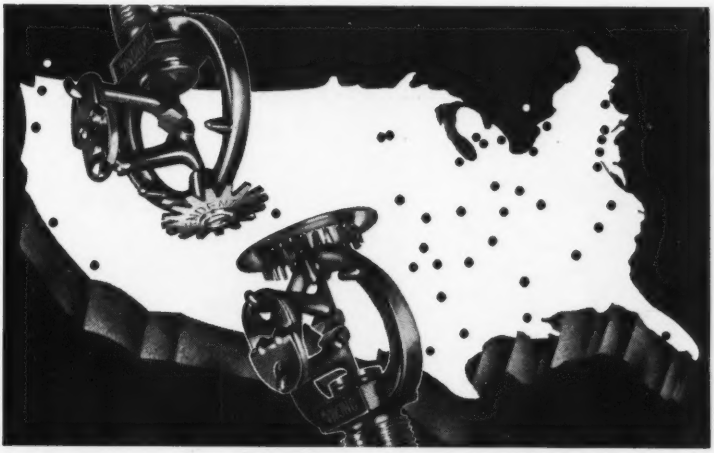
for jobs specifying ¾" to 14" grooved pipe. Double rib construction gives great strength with least weight.

ROLAGRIPS and GRUVAGRIPS are listed for use in sprinkler systems by Factory Mutual and Underwriters' Laboratories. Their simple construction makes installation a snap. Just three parts — twin housing halves and synthetic rubber gasket — held by two bolts. Re-usable. ROLAGRIPS and GRUVAGRIPS are leakproof under working pressures to 1,000 psi, end pull to 102,000 pounds. They automatically absorb shock, vibration, deflection to 7°, expansion and contraction.

Write today for prices and new free illustrated couplings folder 55-F. Or see ROLAGRIPS and GRUVAGRIPS (and companion GRUVAGRIP FITTINGS) at your supply store.

GUSTIN-BACON MANUFACTURING CO.

210 West 10th Street **Kansas City, Missouri**



VIKING SPRINKLER FIRE PROTECTION

for any condition whatever it happens to be!

ATLANTA — Crawford & Slaten Co. BOSTON—Viking Automatic Sprinkler Co. BUFFALO—Viking Automatic Sprinklers, Inc. CHICAGO, MILWAUKEE — Viking Automatic Sprinkler Co. CINCINNATI, CLEVELAND, INDIANAPOLIS, LOUISVILLE —Viking Sprinkler Co. DALLAS, HOUSTON, JACKSON (Miss.), MEMPHIS, NEW ORLEANS, N. LITTLE ROCK, SAN ANTONIO, TULSA — Texas Automatic Sprinkler Co. DETROIT — Viking Sprinkler Co. GRAND RAPIDS — Viking Sprinkler Co. of Western Mich. HIGH POINT, N. C. — Viking Sprinkler Co. HUNTINGTON, W. VA.—C. W. Hutchinson, Inc. DECATUR (Ill.), DENVER, KANSAS CITY (Kan.), OMAHA, SAINT LOUIS — Walton Viking Co. LOS ANGELES, SAN FRANCISCO—California Viking Sprinkler Co. HILLSIDE (N. J.), NEW YORK, MANCHESTER (Conn.) — Viking Sprinkler Co. PHILADELPHIA, WASHINGTON (D. C.)—Viking Sprinkler Co. PORTLAND (Ore.), SEATTLE, VANCOUVER (B. C.) — Viking Automatic Sprinkler Co. ST. PAUL, MINNEAPOLIS—Hudson Viking Sprinkler Co. TAMPA — Florida Fire Sprinklers, Inc. TORONTO (Ont.) — Viking Automatic Sprinklers, (Canada) Ltd. WINNIPEG (Man.) — J. C. Davis, Ltd. HASTINGS (Mich.) — The Viking Corporation.

the VIKING corporation

HASTINGS, MICHIGAN

World's Fastest Fire Detector

. . . sees fire with the speed of light

. . . instantly actuates alarm or extinguishing systems

. . . a single system protects up to 200,000 square feet

. . . makes outdoor protection practical for the first time

For greatest fire protection, you need instant fire detection . . . and only Fireye can give it to you.

This proved device sees the flame when it first flickers. It doesn't wait for smoke or heat to indicate a fire already out of control.

For further information about Fireye — the world's fastest fire detector — send coupon below.

fireye DIVISION

E C A

Electronics Corporation of America
Dept. F26-7
77 Broadway, Cambridge 42, Massachusetts

Please send me your new descriptive bulletin, "Fireye . . . the new standard in fire detection."

Name.....

Company.....

Address.....

Underwriters' Laboratories, Inc.

INSPECTED

TYPE EX POWER-OPERATED
INDUSTRIAL TRUCK
FOR HAZARDOUS LOCATION
CLASS 1 GROUP D NO. 101

Designed not only for safety but also economy . . .

Clark's new EXPLOSION-PROOF Carloader

Clark's electric Explosion-Proof Carloader was specifically designed to meet the rigid requirements of Underwriters' Laboratories, Inc. It was the first lift truck to receive Type EX, Class I Group D approval. It is safe for operation in atmospheres containing explosive fumes and vapors, such as gasoline, lacquer, propane.

In addition to *Safety*, the new Explosion-Proof Carloader provides outstanding economy and battery efficiency. It utilizes the same basic control system which enables *all* Clark electrics to outperform other equipment—to work a longer cycle without recharging batteries.

We invite you to compare the new Explosion-Proof Carloader with any comparable truck on the market. Call your local Clark dealer—listed in the Yellow Pages. Or write for details.

CLARK EQUIPMENT

Industrial Truck Division
CLARK EQUIPMENT COMPANY
Battle Creek 190, Mich.

☐ Send details on "EX" Carloader

Name_____

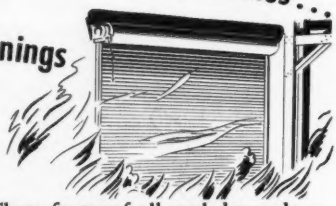
Firm_____

Address_____

City_____ Zone_____ State_____

Kinnear Rolling Fire Doors

Famous "Akbar" Doors cut off drafts... defy flames... block spread of fire at all openings



These fireproof all-steel doors do a *thorough* job of blocking off flame spreading drafts.

YOU'RE SAFER with the *automatic* fire protection of "Akbar" Rolling Fire Doors! Fireproof all-steel doors are out of the way, overhead, when not in use. But when fire threatens, they promptly seal off doorways, windows and corridors.

Positive enclosure is certain because the doors are *pushed* downward automatically, by strong auxiliary springs. A special safety device controls their downward speed, guarding against personal injury and reducing impact force on the floor.

For emergency exit, the doors can be raised after automatic closure. They will then close again, quickly and automatically.

Tested and labeled by Underwriters' Laboratories Inc., Akbar Fire Doors often save enough in reducing insurance rates to pay for themselves in two or three years. Built to fit doorways, windows and other openings of any size, they can be equipped to fit regular, daily service use, with or without motor operation. For service use only, standard "non-labeled" Kinnear Rolling Doors are preferred. Write for details.

Saving Ways in Doorways

KINNEAR
ROLLING DOORS

The KINNEAR Manufacturing Co.
Factories: 2250-70 Fields Ave., Columbus 16, Ohio
1742 Yosemite Ave., San Francisco 24, California
Offices and Agents in Principal Cities

The Wonders of RESEARCH

M H

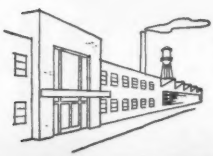
Perhaps we are prone to see only the more spectacular phases of modern research, such as the development of antibiotic drugs, television, or jet planes. As a matter of fact, modern life probably depends more on the development of more common products.

For example, consider valves and hydrants, which most people take more or less for granted but without which a modern water works could not function. And without water works, modern cities could not exist.

There is no romance about valves and hydrants, nothing spectacular. Yet M&H Valves and Hydrants are the products of many years of research in engineering, design, metal strength and structure, foundry practice, and water works operation.

These M&H products enjoy the confidence of engineers because they give top performance year-after-year in a service vital to the American way of life. For details, write M&H VALVE & FITTINGS COMPANY, Anniston, Alabama.

M&H PRODUCTS FOR WATER WORKS • FILTER PLANTS INDUSTRY • SEWAGE DISPOSAL AND FIRE PROTECTION



Von Duprin fire and panic exit devices

"THE SAFE WAY OUT!"

In buildings of all types all over the nation . . . wherever "safe exit" is a factor . . . Von Duprin devices are on duty.

Through proved performance and continuous improvement—ever since Von Duprin marketed the original exit device in 1908—these products have earned the confidence and trust of all safety-minded people.

For expert help in selecting the type of device best suited to your needs, call on your Von Duprin "Exit Specialist." For his name, write Von Duprin, or contact the contract hardware distributor in your own community.

VONNEGUT HARDWARE CO. • VON DUPRIN DIVISION
INDIANAPOLIS 9, INDIANA

RELIABLE SPRAY SPRINKLER

RELIABLE
Greater Coverage!
Lower Ceiling Temperatures!
Faster Cooling of Hot Fire Gasses!
Better Fire Extinguishment with Less Water!
Fewer Sprinklers Operating Adjacent to Fire Area!

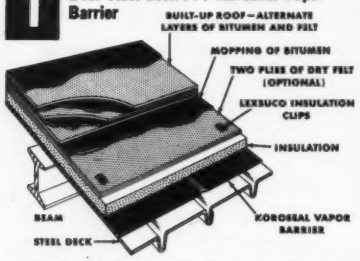
Incorporating the new principle of water distribution, the Model "C" Spray Sprinkler is another example of Reliable's leadership in new product design. All Reliable Sprinkler Devices are the assurance of the ultimate in fire protection . . . and have been protecting life and property for over 30 years! Reliable Sprinkler Devices are distributed . . . installed and serviced by Reliable's chain of licensed representatives located throughout the United States, Canada and foreign countries. A Reliable representative is as near as your phone. . . . Call him for a system designed to your specific needs!

Constant Fire Protection That's Always "Reliable"!

THE RELIABLE AUTOMATIC SPRINKLER CO. INC.

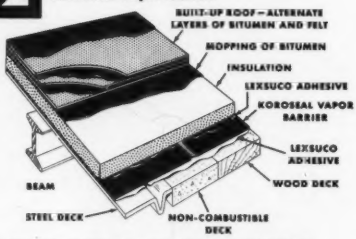
5 LEXSUCO FIRE-SAFE ROOFS

1 Over steel deck . . . Koroseal Vapor Barrier



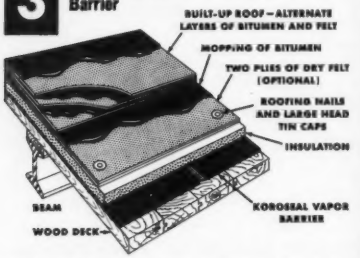
● *fire-retardant* ● *uses Lexsuco Clips*

2 Over steel, concrete or wood deck . . . Koroseal Vapor Barrier



● *fire-retardant* ● *uses Lexsuco Adhesive*

3 Over wood deck . . . Koroseal Vapor Barrier



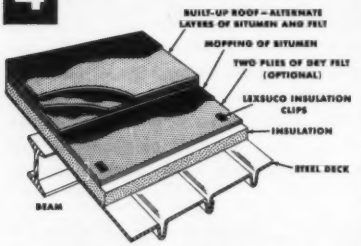
● *fire-retardant* ● *uses nails and tin caps*

At no more cost than conventional roofing, these five new Lexsuco Roof Designs fill the need for superior industrial and commercial roofs having greater fire resistance. Utilizing standard built-up roofing materials, they can be applied over any type deck.

Outstanding features of these designs are: Koroseal Vapor Barrier—the tough elastic sheeting that is highly resistant to vapor transmission and does not support combustion; Lexsuco Clips and Lexsuco Adhesive—the modern, fire-safe devices which provide high-strength fastening of Koroseal Vapor Barrier and/or insulation to decks.

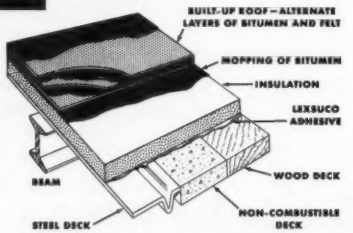
For all your built-up roofing applications, specify "Lexsuco Roof Constructions".

4 Over steel deck . . . no vapor barrier



● *fire-retardant* ● *uses Lexsuco Clips*

5 Over steel, concrete or wood deck . . . no vapor barrier



● *fire-retardant* ● *uses Lexsuco Adhesive*

To get further details on these Lexsuco Roof Designs, see our catalog in Sweet's Architectural and Industrial Construction File.

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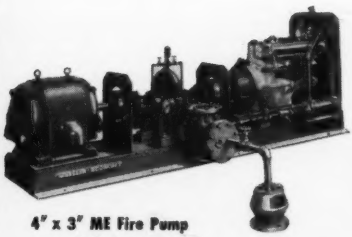
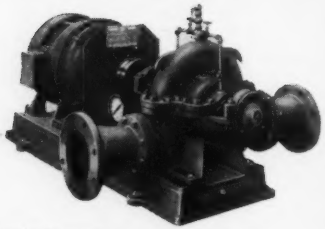


4" x 3" ME Fire Pump with dual drive.



Wheeler-Economy Fire Pump fitted for Booster Service.

WHEELER-ECONOMY FIRE PUMPS

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- Centrifugal Booster Pumps
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You can recommend Wheeler-Economy Fire Pumps for the needs of all commercial, industrial, public and private buildings.

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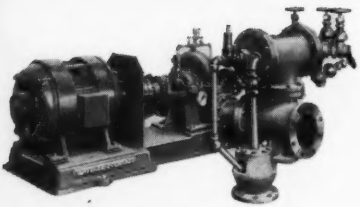

Economy Fire Pump complete with Discharge Tee, Hose, Valves, Waste Cone, etc.

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WE514

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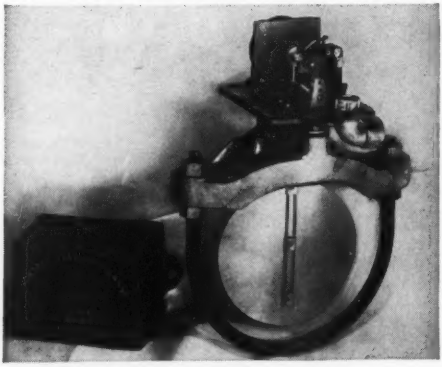

5-inch size shown above. To install simply drill 2-inch hole in pipe.

Model PRS-1 Sprinkler Waterflow Alarm

This device is approved by Factory Mutual Laboratories and Underwriters' Laboratories, Inc.

- This device is also made as Model PRT-1, a coded waterflow transmitter.

- Also made in explosion proof models.
- Made in all sizes from 2½" to 8".
- Has instantly recycling pneumatic retarding device, which prevents false alarms.
- Has enclosed electrical contacts for 15 amp. 125 volts, A.C. and ½ AMP, 125 volts, D.C.

Size is 1⅝" x ⅝"

Tempo-Set Model A Fire Detector

Underwriters' Laboratories, Inc. Approved.

- Self restoring and can be heat tested.
- Electrical contacts are silver or gold and are enclosed.
- Very reasonable price.

- Tempo-set Model A is approved in either open or closed circuit and the temperature ratings are 140 and 200 degrees.
- Approved spacing is 20' x 20'.
- Electric ratings are 125 volts 1 ampere, A.C. or 24 volts 0.5 ampere D.C., or less.

Report on

SHEETROCK* FIRECODE 60

What it is: SHEETROCK Firecode 60 gypsum wallboard is 5/8-inch SHEETROCK with a specially formulated core of gypsum and other incombustible materials. It was developed by U.S.G. to meet rigid code requirements in single layer application for new construction or remodeling.

What it does: SHEETROCK Firecode 60 has received the One-Hour Fire Retardant Classification Label of Underwriters' Laboratories for:

A. Conventional wood stud partitions faced each side with 5/8" SHEETROCK Firecode 60.

B. Conventional wood floor and ceiling constructions with ceiling surfaced with SHEETROCK Firecode 60 Gypsum Wallboard.

C. **New**—Steel joist and concrete Floor Construction, protected with ceiling of SHEETROCK Firecode 60, having either taped or untaped joints; various methods of attaching SHEETROCK Firecode 60 to steel joists.

SHEETROCK Firecode 60 has received a 2-hour Fire Retardant Classification Label of Underwriters' Laboratories for:

Conventional wood stud partitions faced each side with two layers of SHEETROCK Firecode 60 Gypsum Wallboard.

New—Flame Spread rating. A fire hazard classification rating of 10 to 15 is now applicable to this product.

You can recommend and approve SHEETROCK Firecode 60 with full assurance that this product is made to the high quality standards for which U.S.G. products are famous.

For complete data and specifications for erection, consult your local U.S.G. Architects' Service Representative, or write United States Gypsum, 300 W. Adams, Chicago 6, Ill.

*T. M. Reg. U. S. Pat. Off.

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AUTOMATIC FIRE ALARMS AUTOMATICALLY KEEP SMALL FIRES SMALL

First when seconds count!

Fire strikes and spreads so rapidly that any delay — even seconds — in notifying the Municipal Fire Department can be disastrous . . . might put you out of business permanently.

You can depend on a Gamewell Fire Alarm System to contact the Municipal Fire Department *immediately* and *automatically* when a sprinkler head goes off or an alarm box is pulled . . . no guesswork . . . no costly delays!

Easily added to your present sprinkler system, a Gamewell Fire Alarm System safeguards your personnel, your plant and your production. Get *complete* protection . . . write NOW for the name of your nearest representative.

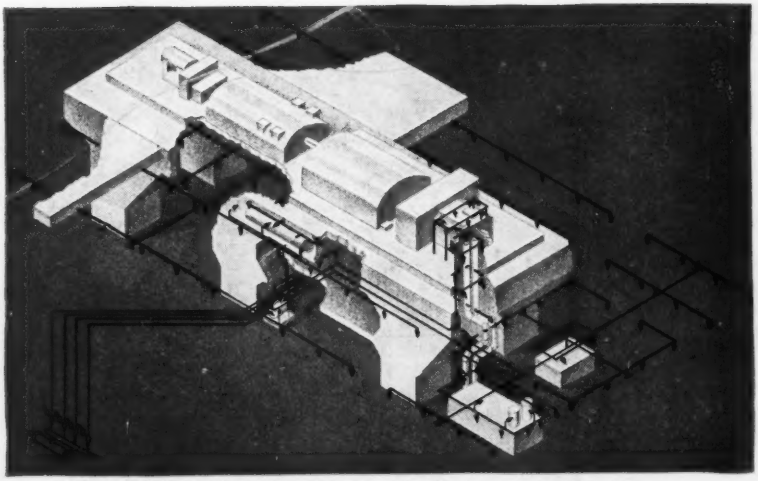
GAMEWELL

THE GAMEWELL COMPANY
Chestnut St., Newton Upper Falls 64, Mass.

FIRE ALARM SYSTEMS

SAFETY ENGINEERED FOR YOUR PROTECTION

Complete Fire Protection for Turbine Oil Systems



Typical Turbine Oil Mulsifyre System, sectionalized and actuated either automatically or by remote manual control

The severity of turbine oil fires of recent years, and the heavy losses resulting from them, have proved the need for an efficient protection system throughout the *whole* area of hazard. One of the most practical extinguishing agents for oil fires is water spray — and, one of the most effective methods of producing water spray is a Grinnell Mulsifyre System.

Grinnell Mulsifyre attacks oil fires in these different ways:

- By forming a fire-extinguishing blanket of emulsion on the surface of the oil.
- By introducing water vapor molecules between the oil vapor and oxygen molecules, to make the mixture unburnable through "vapor dilution".
- By cooling oil at its surface, thus slowing down production of burnable vapor.
- By using up heat through flash evaporation of water, to keep oil vapor below the ignition point.

Grinnell manufactures and installs fire protection systems for every normal or special fire hazard — Grinnell Automatic Sprinkler Systems for standard risks; Grinnell Mulsifyre, ProtectoSpray, Multitrol Deluge, ProtectoFoam, C-O-Two, and dry chemical systems for special or extra-hazardous risks. Write for your free copy of "Occupancy Fire Record in Electric Generating Stations" and "Turbine Oil Fire Protection". Grinnell Company, Inc., 274 West Exchange St., Providence, R. I. Branch Offices in principal cities.

GRINNELL *Mulsifyre*

EMULSION EXTINGUISHMENT OF OIL FIRES